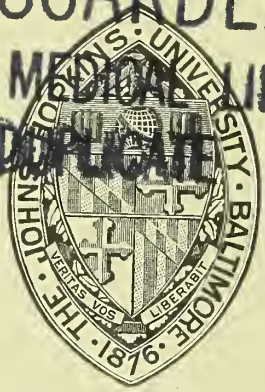
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MANUAL

OF

GENERAL, DESCRIPTIVE, AND PATHOLOGICAL

ANATOMY,

BY

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TRANSLATED FROM THE GERMAN INTO FRENCH,

WITH ADDITIONS AND NOTES,

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TRANSLATED FROM THE FRENCH,

WITH NOTES,

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MANUAL

OF

GENERAL, DESCRIPTIVE, AND PATHOLOGICAL

ANATOMY.

DESCRIPTIVE ANATOMY.

SECTION II.

OF THE PERIPHERY OF THE NERVOUS SYSTEM.

§ 1809. The periphery of the nervous system, comprehending the nerves properly so called, is divided into three sections: the *nerves of the spinal marrow* or the *spinal nerves*, the *nerves of the brain* or the *encephalic nerves*, and the *ganglionnary* or *great sympathetic nerve*. The number of these nerves, including the last, is forty-three pairs. But anatomists do not divide them in the same manner, for several cerebral nerves have been blended which are now considered as distinct pairs; and farther, some consider as cerebral nerves those which others refer to the spinal pairs.

We shall point out the differences arising from the first of these sources in our general remarks on the cerebral nerves. Those which arise from the second depend principally upon the division of the central mass of the nervous system. If the medulla oblongata be considered as the summit of the spinal marrow, we must naturally arrange the nerves arising from it among the spinal pairs; hence their number is increased, while that of the cerebral pairs is diminished.

Thus Gordon admits only eight pairs of cerebral nerves and thirty-four pairs of spinal nerves. Bichat makes three classes, the first comprising two nerves of the cerebrum, the second six of the mesocephalon, and the third thirty-four spinal nerves. Others with Portal, tacitly admit another intermediate class in which the accessory nerve is placed, which in the general method belongs to that of the cerebral nerves. Others as Sabatier, Bichat, and Cloquet, following Willis, exclude the first nerves of the spinal marrow from the number of spinal pairs, and consider them as the most inferior cerebral nerves.

This last method is the least natural of all, for although the upper pair of the spinal nerves is often between the cerebral and spinal nerves in character, as may be seen from the description, still it is more like the latter than the former. The want of exactness in considering the last four cerebral nerves as the first spinal pairs, is also proved by the contradiction between the general characters of these four nerves and those of the spinal marrow, and it then becomes impossible to generalize about these last. This classification is farther very inconvenient, since a slight examination demonstrates that certain nerves (for instance, the auditory and external motor nerves) arise from the same region of the central part of the nervous system; and with a little care and patience this may be proved of most of the others. The same reasons which impelled us to separate the medulla oblongata from the spinal marrow, and to consider it as a portion of the encephalon, have obliged us to place the nerves derived from it among the cerebral. The characters of these nerves, which resemble those of the cerebral rather than those of the spinal nerves, demonstrate also the superiority of our method.

We shall first examine the spinal nerves, not only because we have already treated of the spinal marrow when describing the cervical part of the nervous system, but because from the cerebral nerves, which will be mentioned last, we shall naturally pass to the organs of sense, and from them to the more complex organs, with which we shall close the treatise.

CHAPTER I.

NERVES OF THE SPINAL MARROW.

§ 1810. We have already mentioned the general characters of the *nerves of the spinal marrow* :(1) they are divided into as many sections as there are regions in the vertebral column, consequently into *cervical*, *thoracic*, *lumbar*, and *sacral nerves*.

We shall first describe the thoracic nerves, except the first one, because they are more simple and arise the first; next the nerves of the limbs, those of the inferior extremities arising from most of the

(1) J. J. Huber, *De medullâ spinali, specialim de nervis ab eâ provenientibus*, Gottingen, 1741.—G. Frotscher, *De medullâ spinali ejusque nervis*, Erlangen, 1788.

sacral and lumbar nerves, those of the superior from the first dorsal and the last four cervical; finally, the four superior cervical nerves, which lead by a remarkable transition to the cerebral nerves.

Before describing minutely the nerves of these different regions, we ought to make known the following characters which belong to them in common, and which are important in regard to their topography.

1st. There is no constant difference between the nerves of the right and those of the left sides.

2d. The nerves are not perfectly symmetrical; one is often situated higher than another, and the number of cords is frequently greater by two or three on one side than on the other. But this difference is almost always compensated for, because then the adjacent pairs vary in the opposite manner.

3d. The upper and lower pairs are much nearer each other than the central. The latter also after the last dorsal nerve, are so near each other that they do not seem like separate nerves. They are also much nearer in the early periods of existence, and even during the first years of life, than at subsequent periods. This propinquity in the superior and inferior regions, is owing to the disproportion between the size of the nerves and the shortness of that part of the spinal marrow from whence they arise. Hence why the smaller thoracic nerves, which arise not much above the place from whence they leave the spinal marrow, are farther from each other, and the reason of the greater distance between the spinal nerves in animals whose necks are longer, and in whom too the spinal marrow descends lower than in man.

4th. The ganglions formed by the posterior roots are situated in the intervertebral foramina, except those of the sacral nerves which are found in the cavity of the sacrum.

These ganglions are not all of the same size in all regions, and their development is not in a direct ratio with that of the nerves. In fact, a ganglion which is usually large, is not unfrequently replaced by another very small, and *vice versa*. The ganglions of the dorsal nerves are generally the largest, and those of the sacral nerves, especially the last, the smallest.

5th. All the spinal nerves divide soon after coming from the vertebral column into two branches, an anterior and a posterior, the first of which is often larger than the other, excepting always those of the second cervical nerve, which presents a contrary arrangement. The anterior branches turn first outward, then forward and inward, and terminate near or upon the anterior median line. The posterior go directly backward, and are distributed to the muscles which fill the groove between the spinous and transverse processes of the vertebræ, or in those which correspond to them in the cranium and the skin of this region. The first are distributed to the anterior muscles, which represent these dorsal muscles on the sides and anteriorly, and in those of the extremities.

6th. All the spinal nerves communicate together very constantly by one or several larger or smaller branches which they give off soon after leaving the vertebral canal, and which anastomose with those analogous.

The anastomosing branches usually arise from the anterior part of the nerves, or belong only to their anterior branches, and go before the transverse processes on the sides of the bodies of the vertebræ. The brachial, lumbar, and sacral plexuses, are formed entirely in this manner; their arrangement, however, differs from that usually seen, being more complex, since the anastomosing branches produce others which anastomose several times with those near. Nerves composed of filaments from several trunks of different origins, arise from these points of union whether single or multiple.

One or more anastomosing branches communicate at the same time with the branches of the ganglionnary system in the limiting ganglions.

Besides these anterior anastomosing branches which form along the vertebral column, a series of plexuses, corresponding in number to that of the vertebræ, the posterior branches also anastomose in an analogous manner, especially at the upper region of the neck, although this arrangement is less general posteriorly than anteriorly.

ARTICLE FIRST.

DORSAL NERVES.

§ 1811. The *dorsal*, *thoracic*, *costal*, or *intercostal* nerves (*N. thoracici*, s. *dorsales*, s. *costales*, s. *intercostales*) are like the dorsal vertebræ, twelve in number. Some anatomists, however, as Haller,(1) count only eleven, and annex to the lumbar nerves that usually regarded as the twelfth. We shall examine only the eleven inferior nerves, as it is more convenient to describe the first with the four inferior cervical nerves.

The general characters of these nerves are as follow:

1st. They make part of the smaller nerves of the spinal marrow, and are particularly smaller than the inferior cervical, the lumbar, and the superior sacral nerves.

2d. Most of them, especially the inferior, are those spinal nerves which arise farthest from each other. Still the superior are nearer to each other than the superior cervical nerves are.

3d. Most of them communicate only by intermediate filaments in the vertebral canal. Still we have often found between the first and second pairs, as between the second and third, a filament, proceeding obliquely from above downward, and from within outward, from the su-

(1) *El. phys.*, lib. x. not. 38.

perior edge of the inferior nerve to the inferior edge of the nerve situated immediately above. They have always seemed smaller between the second and third pair than between the first and second.

4th. Their trunk furnishes on emerging, and immediately after, some thin short branches which go forward and enter either into the nearest limiting ganglion of the ganglionnary nerve, or more rarely into the filament of communication between two of these adjacent ganglions. It then divides soon after emerging into two branches, one *anterior*, *intercostal*, or *subcostal* (*R. intercostalis*, s. *subcostalis*), the other *posterior* or *dorsal* (*R. dorsalis*).

The anterior branch proceeds under the rib, below which the trunk comes from the vertebral canal, between the external and internal intercostales muscles, and advances as far as these last extend. It accompanies the intercostal vessels lodged more or less immediately in the groove of the rib. In its course it gradually leaves the superior rib, so that its anterior part is nearer the rib below than that above. It then perforates the intercostales muscles near the sternum, and becomes external. Proceeding, it gives branches to these muscles, the upper part of the abdominal muscles, and to the skin which covers the intercostales muscles. These last filaments called the *external thoracic* nerves (*R. pectorales externi*), successively perforate the intercostales muscles from behind forward, but all arise very far from the place where they emerge.

Each anterior branch near its origin, sends off posteriorly several branches, of which the *internal* are usually numerous, and go, independently of those coming from the trunk, to the limiting ganglions of the ganglionnary nerve and their filaments of union, and anastomose in this place with the analogous branches of the adjacent dorsal nerves, while the *external* which are simple, pass on the internal face of the ribs, and communicate with those of the two adjacent dorsal nerves which go to meet them. These last are sometimes deficient in the middle pairs: but their absence is not always observed, as they not unfrequently occur there, although they are more developed in the upper and lower pairs.

The posterior branch proceeds backward between the transverse processes of the vertebræ, between which it arises under the multifidus spinæ muscle, and there usually divides into external and internal branches, the latter of which are smaller and are deficient when the division does not take place.

The *internal* branches are distributed to the multifidus spinæ, the semispinalis, the spinalis, the internal belly of the sacro-lumbalis, the digastricus nuchæ, the complexi, the transversalis, the inferior portion of the splenius, the rhomboidei, the trapezius, and the latissimus dorsi muscles.

The *external* branches proceed outwardly, emerge between the scalenus muscle and the internal belly of the sacro-spinalis, and in this place penetrate between the two bellies of the latter muscle, to which they are distributed and also to the superficial muscles of the back.

Besides, these two branches usually, but not always, extend to the skin.

All the dorsal nerves are not of the same size. Except the first, which is the largest, they go on increasing in size much from the second to the last. However, they do not enlarge uniformly; Haller(1) and Sœmmerring have observed, and the results of our numerous dissections also coincide with their opinion, that the the fourth, sixth, and eighth, are smaller than the fifth, seventh, and ninth.

§ 1812. The differences in the distribution of the thoracic nerves, depend principally on their anterior or intercostal branches.

The first is remarkably distinguished from the others. It soon goes upward and outward above the first rib, toward the brachial plexus, and opposite to this rib divides into two branches. One which is proportionally very small, goes forward and proceeds below the first rib like the anterior branches of the other thoracic nerves. The second is much larger, and ascends and corresponds to the small anastomosing branches of the other thoracic nerves; it immediately unites with the brachial plexus, with which we shall describe its farther progress.

The anterior branches of the second and third thoracic nerve, together furnish to the skin of the arm an inferior branch, which may be called the *brachial* nerve. Both then send some filaments to the intercostales muscles, penetrate the external, then descend to the integuments at the axilla and unite, but not always uniformly, with the internal cutaneous nerve of the arm, and expand in the superior and internal part of the integuments of the arm, so that their filaments, especially those of the second pair, descend to the elbow.

Anteriorly, the anterior branches of these two nerves terminate in the anterior part of the pectoralis major and the triangularis sterni muscle. In their passage they furnish no constant branches to the abdominal muscles.

The anterior extremities of the anterior branches, and of the second, third, fourth, fifth, sixth, and seventh thoracic nerves, are distributed also in these two muscles, the skin of this region, and the thymus gland. The external pectoral twigs of these branches penetrate into the upper part of the obliquus externus and rectus abdominis muscles, also in the skin which covers them.

The anterior extremities of the anterior branches of the eighth, ninth, tenth, and eleventh thoracic pairs, pass above the costal digitations of the diaphragm, glide between the obliquus internus and transversalis abdominis muscles, distribute filaments to these muscles, and then go to the posterior face of the rectus muscle and to the skin which covers it.

The external pectoral twigs of these branches are distributed in the upper part of the obliquus abdominis internus muscle and the skin near it.

(1) *De part. corp. hum.*, vol. viii. p. 399.

The eleventh thoracic nerve gives filaments to the posterior part of the diaphragm.

The twelfth, described by Haller as the first lumbar nerve, anastomoses by a large branch with the first lumbar pair, and sends filaments to the diaphragm, then passes before the superior part of the quadratus lumborum muscle, between it and the posterior tendon of the transversalis, gives off filaments and divides at its external edge into superficial and deep abdominal branches. The former pass between the transversalis and obliquus internus abdominis muscles, and terminate there, and also in the lower part of the rectus and pyramidalis muscles. The second go between the two oblique muscles, pass through the external, and are distributed to the integuments of the abdomen as far as the ossa ilia.

ARTICLE SECOND.

LUMBAR AND SACRAL NERVES.

§ 1813. The description of the *lumbar* and *sacral*(1) nerves ought to follow that of the thoracic, because by then describing the cervical, we proceed from below upward to the explanation of the encephalic nerves. We shall combine our observations in regard to these two orders of spinal nerves, because they resemble each other in their most essential characters, and particularly as they unite to form the nerves of the inferior extremities.

The five lumbar nerves and the sacral nerves, which are also five and sometimes six in number, arise near each other from the inferior prominence of the spinal marrow. They emerge from the medullary canal, the lumbar passing out through the intervertebral foramina, situated between the lumbar vertebræ as between the last one and the upper surface of the sacrum. The sacral nerves form the sacral foramina, except the last, which passes between the sacrum and the first piece of the coccyx. Not only the anterior and posterior roots of each pair, but the different pairs themselves are closely united to each other from their origin to the ganglions formed by their posterior branches; but neither the first nor second communicate by intermediate filaments. The sacral nerves differ from all other spinal nerves by the situation of their ganglions, which do not anastomose when coming from the nerve, but in the channel of the vertebral column, and are as much more distant from the sacral foramina the lower the origins of the nerves to which they belong, so that the anterior and posterior roots of these last unite even within the medullary canal. The trunks resulting from their union divide near their origin, and also within the vertebral canal, into anterior and posterior branches,

(1) J. L. Fischer, *Descriptio anatomica nervorum lumbalium, sacralium et extremitatum inferiorum*, Leipsic, 1791.

which do not usually anastomose together in this canal, but emerge, the first through the anterior sacral foramina, the others through the posterior sacral foramina. The union of the anterior and posterior roots of the sacral nerves in the medullary canal, undoubtedly corresponds to the fusion of the false sacral vertebræ in a single bone, and it takes place after the same type so evident in the vascular system. Perhaps, also, it partially depends on the greater distance between the point from whence the nerves originate, and that whence they emerge. One circumstance favors this conjecture, viz. that the place where the posterior and anterior roots unite, is farther in the inferior nerves where the trunk is proportionally longer. But this circumstance also favors the opinion first proposed, since the inferior false sacral vertebræ unite also sooner than the superior.

The anterior branches of these ten nerves which enlarge very much, form a plexus which may be called the *femoral* or *crural plexus* (*plexus femoralis*). This plexus, like the brachial and cervical, is produced by the increase and multiplication of the anastomoses between the anterior branches, which is in proportion to the increase of volume of the nerves, and which takes place in breadth, and from without inward, and in thickness or from behind forward.

We may consider separately the superior and inferior parts of this plexus, the first as the *lumbar* or *lumbo-abdominal*(1) *plexus*, the second as the *sacral* or *sciatic plexus*, since from each of these two parts, which are formed, the first by the lumbar, the second by the sacral nerves, arise nerves which are distributed differently. Still as the principal nerves which come from it are all distributed to the lower extremities, it is more convenient to regard them as forming one plexus only, as the inferior lumbar nerves mostly form the sacral plexus and the nerves which come from it.

This plexus is indicated in the dorsal region by the much smaller anastomosis between the anterior branches, and which are constantly developed in the inferior thoracic pairs.

Of the nerves which form it, the upper suddenly enlarge very much from above downward, and the lower from below upward.

The last two sacral nerves are the smallest, and the last especially is the smallest of all the spinal nerves. Next comes the first lumbar, then the third sacral; the second lumbar is a little larger, being about the same size as the second sacral; the third and fourth lumbar which are almost equal, are a little larger than the preceding. The fifth lumbar and the first sacral are much the largest.

Dorsal branches which are much smaller arise from all these nerves which unite to form the crural plexus, commencing before the union of their anterior branches, when they emerge from the foramina: these go directly backward between the transverse processes of the lumbar vertebræ and the sacrum, passing there through the posterior sacral

(1) J. A. Schmidt, *De plexu lumbali, de nervis lumbalique corumque plexu commentarius anatomico-pathologicus*, Vienna, 1794.

foramina. These branches are distributed to the posterior part of the muscles of the back, to the gluteus maximus and the skin which covers them.

The *posterior* branches, the *dorsal* or *lumbar* (*R. postici*, s. *dorsales*, s. *lumbales*), of the lumbar nerves diminish considerably in volume from the first to the last, so that the last two rarely extend to the skin, but are distributed only in the common belly of the sacro-lumbalis and multifidus spinæ muscles. From the first sacral nerve to the fourth, the posterior branches again enlarge much. That of the fourth is the largest; the fifth is smaller, while the sixth is much more minute.

§ 1814. The *anterior* or *abdominal* branches (*R. antici*, s. *abdominales*) of the lumbar nerves pass behind the psoas magnus muscle, unite not only with each other, but beside the first with the anterior branch of the last dorsal, the last with the anterior branch of the first sacral, to form the lumbar plexus, the lumbar ganglion of the ganglionnary nerve, and produce the nerves we are about to describe. The anterior branches of the sacral nerves, principally the first, second, third, and fourth, concur in the same manner to form the sacral plexus to which the fifth contributes least, and the sixth takes no part when it exists.

Some ramifications arise from the anterior twigs after their union, some of which, the smaller ones, are usually formed by the filaments of a single nerve, while others which are larger, arise from the union of fasciculi from several nerves.

The first are principally the external pudic nerve, several branches for the muscles in the lumbar region, the skin of this region and the common integuments of the inguinal region, the gluteal nerves and the inferior and middle hemorrhoidal nerves.

The second are the three nerves of the lower extremities, the obturator, the crural, and the gluteal nerve.

A. SMALL NERVES WHICH ARISE FROM THE ANTERIOR BRANCHES OF THE LUMBAR AND SACRAL NERVES.

§ 1815. *First and second lumbar nerve.* From the first and second lumbar nerve, especially from the inferior extremity of the *plexus* between them, arises the *external pudic* or the *genitocrural* nerve (*N. pudendus externus*, s. *spermaticus externus*, s. *inguinalis*, s. *genito-cruralis*), which passes between the superior digitations of the psoas muscle, arives at the anterior face of this muscle, on which it goes from behind forward and from above downward, and divides within the pelvis into branches which all emerge from the inguinal ring. Among these, the most considerable which are always the continuation of the trunk, arrive at the spermatic vessels, and are distributed in the male in the cremaster muscle and its coats, and in the female in the round ligament of the uterus, and anastomosing with the inferior pudic nerves, terminate in the glands and integuments of the inguinal region. The external passes under the crural arch, penetrates the aponeurosis, is dis-

tributed in the skin to the middle of the internal face of the thigh, and anastomoses with some filaments of the crural nerve.

Besides there arise from the first lumbar nerve and its anastomosis with the second, branches designed for the psoas, the quadratus lumborum, and the transversalis abdominis muscles, and for the integuments of the lumbar and inguinal regions. One of these branches, which is large, penetrates the psoas muscle, goes forward between the obliquus internus and transversalis along the crest of the ilium, and terminates in the inferior part of the large abdominal muscles and skin of this region and of the scrotum.

Several filaments come from the *second lumbar* nerve and are distributed to the psoas and quadratus lumborum muscles and the skin of the lumbar and inguinal regions: usually there arise one or two distinct branches which are longer (*nerfi lio-scrotal*, Ch.), which passing through the psoas muscle, proceed outwardly before the quadratus lumborum, penetrate the transversalis, then the obliquus internus, to which they give filaments, go forward along the crest of the ilium, perforate the aponeurosis of the obliquus externus, and are distributed to the skin of the inguinal region and scrotum.

3d. The *third lumbar* nerve usually gives off a cutaneous nerve which unites to the preceding one or replaces it either partially or wholly, descends between the psoas and iliacus muscles, emerges from the pelvis, passing under the outward extremity of the crural arch and is distributed to the external and anterior extremities of the integuments of the thigh to the neighborhood of the knee. There it is the *inferior branch* of the *crural* plexus of Bichat, the *inguino-cutané* of Chaussier.

4th. The *fourth lumbar* nerve usually gives branches only to the iliacus muscle.

5th. The anterior branches of the fourth and fifth lumbar nerve unite to form a very considerable trunk, the *lombo-sacral* nerve of Bichat (*N. lumbo-sacralis*), which is much larger than the crural, and give origin in the very cavity of the small pelvis, but always before uniting with the first sacral nerve, to the *superior gluteal* nerve (*N. glutæus superior*), which emerges from the pelvis below the upper edge of the sciatic notch, is distributed to the gluteus medius and minimus, and penetrates even forward to the tensor vaginæ femoris.

6th. From the *second* and *third sacral* nerve, come some fasciculi which unite, then give filaments to the pyramidalis muscle, and coming from the pelvis below it, go to form the inferior gluteal nerve.

Before these fasciculi, a very considerable nerve arises from these same nerves farther below and forward, sometimes also from the fourth sacral nerve, called the *external common hemorrhoidal* nerve (*N. pudendo-hæmorrhoidalis communis externus*), which re-enters into the pelvis, between the two sacro-sciatic ligaments, and divides into two branches, the *external pudic*, and the *inferior hemorrhoidal* nerve.

The *external* or *superior pudic* nerve, *ischio-pénien* or *ischio-clitoridien*, Ch. (*N. pudendus externus*, s. *superior*), goes along the ascending

branch of the ischium and the descending branch of the pubis, proceeding on gives branches to the obturator internus and bulbo-cavernosus muscles, then passes under the symphysis pubis to go forward, as the *dorsal nerve of the penis* (*N. dorsalis penis*) in the male, and that of the *nerve of the clitoris* (*N. clitorideus*, s. *pudendus superior*) in the female, proceeds along the penis and clitoris, sends filaments to the skin which covers them, and also to the mons veneris and mucous membrane of the urethra, and terminates finally in the glans.

The *inferior hemorrhoidal* nerve, called also the *inferior pudic* (*N. hæmorrhoideus*, s. *pudendus inferior*), partly accompanies the preceding, then goes upward between the bulbo- and ischio-cavernosus muscle, is distributed to the integuments and in all the muscles of the perineum to the inferior extremity of the rectum, the skin of the scrotum and mucous membrane of the urethra, and anastomoses with the external pudic, the inguinal and internal hemorrhoidal nerves.

From the difference in size between the penis and clitoris, the external pudic is the larger of these two branches in the male, while the internal hemorrhoidal is the larger in the female.

7th. The *third* and the *fourth sacral* nerves also give off the *middle hemorrhoidal* nerves (*N. hæmorrhoidales medii*), which are smaller, and not united at their origin; but this term is not exact for they are distributed partly to the rectum, the levator and sphincter ani muscles, and proceed on the side of this intestine to be distributed from below upward in the walls of the bladder, at the commencement of the urethra, uterus, and vagina, the prostate gland and vesiculæ seminales in the male, and frequently anastomose with the lower part of the great sympathetic nerve to give origin to the hypogastric plexus.

8th. The *fifth* and *sixth lumbar* nerves, when they exist, are in fact connected with the crural plexus, but do not contribute to form the nerves which come from them. Their anterior branches are distributed to the sacro-coccygeal, the levator, and sphincter ani muscles. Their posterior are distributed in the integuments of the posterior part of the anus and perineum.

B. LARGE NERVES WHICH ARISE FROM THE ANTERIOR BRANCHES OF THE LUMBAR AND SACRAL NERVES, OR NERVES OF THE INFERIOR EXTREMITIES.

I. OBTURATOR NERVE.

§ 1816. The *obturator* nerve, *sous-pubio-fémoral*, Ch. (*N. obturatorius*),(1) the smallest of those belonging to this division, arises from the most anterior fasciculi of the second, third, and fourth lumbar nerves, rarely from the first, by an equal and sometimes greater number of

(1) See in regard to this and the following nerve, M. C. Styx, *Descript. anat. nervi cruralis et obturatorii*, Jena 1782.

roots, which meet at acute angles. It descends into the lower pelvis, before the following nerve, is covered by the psoas muscle, goes forward along the linea innominata, accompanied by the vessels of the same name, comes out through the obturator foramen, and divides into two branches, an anterior superficial and large and a posterior deeper and smaller.

The anterior branch is distributed to the gracilis, the adductor longus, and brevis muscles, and sends to the internal saphena nerve some branches which are sometimes so large that this last seems to arise from it rather than from the crural.

The posterior branch is distributed in the obturator muscles, particularly the externus, and in the adductor magnus muscle, even descending to near its inferior extremity.

II. CRURAL NERVE.

§ 1817. The *crural* nerve, *fémoro-prétibial*, Ch. (*N. cruralis*), is larger than the preceding, behind which it is situated, arises from the posterior part of the first, second, third, and fourth lumbar nerves, descends along the posterior and external side of the crural artery, between the psoas and iliacus muscles, gives several branches to these two muscles, but principally to the second, and furnishes one considerable which sometimes come off higher than the branches destined to the iliacus muscle, anastomoses near the crural arch with another branch which arises in this place, comes sometimes also from the fourth lumbar nerve, and then is distributed in the integuments of the anterior and internal face of the thigh. This branch is called the *superior* or the *small saphena* nerve (*N. saphenus superior*, s. *minor*).

A branch is generally given off a little below the crural arch which proceeds from within outward, and goes to the common lower extremity of the iliacus and psoas muscles.

The nerve then divides generally below the crural arch into two branches, an external larger, and an internal smaller, above.

The external branch also soon divides into several twigs, which go to the four heads of the extensor of the leg, to the crurœus, and to the tensor vaginæ femoris muscle. These branches descend to the articulation of the knee and penetrate into its capsule.

The internal branch gives to the sartorius muscle many twigs, most of which enter its middle and inferior part. It gives them also to the skin of the internal face of the thigh. But the largest of all the branches which come from it is the *internal saphena* nerve, *tibio-cutané*, Ch. (*N. saphenus internus*). This nerve accompanies the internal saphena vein, which it surrounds at several different parts, distributes some filaments to the integuments of this region, descends on the back of the foot, and extends even to the great toe.

III. SCIATIC NERVE.

§ 1818. The *sciatic nerve*, *grand femoro-poplité*, Ch. (*N. ischiadicus*),(1) the largest of all the nerves, not only of the inferior members, but even of the whole body, arises from the inferior half of the fourth lumbar nerve, and from all the fifth, also from the three superior sacral; the anterior branches unite to form the sciatic or sacral plexus (*plexus sacralis*, s. *ischiadicus*), which is only the inferior part of the crural plexus, although we usually consider this the only plexus of nerves of the lower extremities.

§ 1819. The sciatic nerve sometimes, partially or wholly, gives off the *superior gluteal* nerve and always the *inferior* either wholly or partially. This last emerges sometimes above and sometimes below the pyramidalis muscle, anastomoses with a branch of the sciatic nerve which arises a little lower, and is distributed with it in the gluteus maximus muscle.

§ 1820. The sciatic nerve emerges from the sacral plexus through the sciatic notch, between the pyramidalis and gemelli muscles.

There it sends to the obturator internus a considerable branch which penetrates from without inward between the large and small sciatic ligaments, and enters from below upward into this muscle.

Then it gives a second, which descends before the gemelli and the tendon of the obturator internus, distributes filaments to the first two of these muscles, and is distributed in the quadratus femoris muscle.

Still lower a large branch leaves its posterior part, and unites to the inferior gluteal nerve (§ 1788), with which it goes to the gluteus maximus muscle.

The trunk first gives branches to the flexor muscles of the thigh; then to the long head of the biceps; then to the semitendinosus; farther on, to the semimembranosus muscle; finally, to the short head of the biceps. The filament of the semimembranosus is distributed also to the adductor magnus muscle.

Farther on it gives off the *middle posterior cutaneous* nerve (*N. cutaneus posterior medius*), which descends under the skin of the posterior face of the thigh and leg to the calf, and anastomoses with some filaments of the superior and inferior nerves.

The *inferior posterior cutaneous* nerve (*N. cutaneus posterior inferior*) is given off below this branch; it proceeds in part like the former one, and is partially expanded in the posterior part of the capsular ligament of the knee.

§ 1821. The sciatic nerve then divides into two branches: the internal, the larger, is the *tibial* nerve, and the external, the smaller, the *peroneal* nerve. This division usually takes place at the middle of the thigh, often higher up, and even above the sciatic tuberosity, so that the two branches are separated from each other by the pyramidalis muscle.

(1) J. H. Joerdens, *Descriptio nervi ischiadici*, Erlangen, 1788.

When the bifurcation occurs higher than usual, it is analogous to the arrangement of the sciatic nerve in the mammalia.

Rosenmuller mentions a national difference in regard to the height of this division, viz. that the sciatic nerves divide very high in the inhabitants of the north of Europe, while in those of the south it bifurcates very low not far from the ham.(1) We have not observed this difference.

When the nerve divides high, the two branches are separated by the pyramidalis muscle, and they descend, the external behind, the internal before it.

The *popliteal* nerve (*N. popliteus*) rarely or never exists.(2) At most the name of the *internal* and the *external popliteal* nerve may be given to the upper part of the two terminating branches of the sciatic nerve, from their origin to the femoro-tibial articulation.

a. Peroneal nerve.

§ 1822. The *peroneal* or *external popliteal* nerve (*N. peroneus*) often gives origin to the posterior, inferior, and middle cutaneous nerves. It descends from within outward on the internal side of the biceps femoris muscle, passes between the extensor longus digitorum communis and peroneus longus muscles, sends filaments to these muscles, and likewise to the tibialis anticus, and divides very high up into two branches, the *superficial* and the *deep peroneal* nerves.

§ 1823. The *superficial peroneal*, or the *muscular cutaneous* nerve, *prétibio-digital*, Ch. (*N. peroneus superficialis*), soon divides into two branches, an external superficial and small, the other internal, which is deeper and larger.

The first, or the *cutaneous peroneal* nerve, which might more properly be called the *middle cutaneous nerve of the back of the foot*, or the *external branch of the peroneal* nerve (*N. cutaneus peroneus*, s. *cutaneus medius dorsi pedis*, s. *cutaneus peroneus externus*), descends on the peroneus brevis muscle, passes on the crucial ligaments of the tarsus, is distributed to the skin of the external part of the back of the foot, and terminates by filaments which are the *tibial nerve of the little toe*, the *dorsal nerves of the fourth toe*, and the *peroneal nerve of the third toe*.

The second, the *anterior nerve of the back of the foot* (*N. dorsi pedis anticus communis*, s. *peroneus anticus*, s. *pedalis anticus*), is situated before the former, also near the surface, and is distributed partly to the internal half of the back of the foot, partly to the skin of the external and anterior faces of the leg, and terminates by producing the dorsal nerves of the two external toes and the peroneal nerve of the third.

§ 1824. The *deep peroneal* or *anterior tibial* nerve, *prétibio-sus-plantaire*, Ch. (*N. peroneus profundus*), descends deeply between the

(1) In *Neer Journal der Erfindungen in der Natur-und Arzneywissenschaft*, part ii., p. 100.

(2) Coopmans has made the remark (*Neurol.*, ed. 2, p. 198.

muscles on the anterior face of the tibia, at the side of the anterior tibial artery, but does not pass with it from the posterior to the anterior face of the leg, between the two bones, for the whole trunk of the peroneal nerve is situated and divides on the external face of the fibula.

Such at least is always the arrangement of the deep peroneal nerve according to our observations. Although we have made many careful dissections, yet we have never seen it pursue the course of the anterior tibial artery. Thus, although this authority is sanctioned by a great name,(1) it certainly is not the usual arrangement, and should be considered as a very rare anomaly, more especially as many writers, Coopmans(2) among others, do not sanction it, or speak only of the first.

This nerve gives filaments to the peroneus longus, and to the extensor longus digitorum communis muscle, to the tibialis anticus, and to the extensor hallucis proprius, passes under the crucial ligament of the tarsus, and arrives on the back of the foot, where it terminates in the extensor digitorum brevis, the first interosseous muscle, and the internal part of the skin of this region, by anastomosing with some branches ofthe cutaneous nerve around the foot, so that the dorsal nerves of the large toe more properly arise from this than from the latter.

We have always found the peroneal nerve distributed in this manner, but we have never found that of the two branches into which it divides at the upper extremity of the fibula, one was the external cutaneous nerve, the other, the common trunk of the anterior tibial and internal cutaneous nerves ;(3) Sabatier,(4) Coopmans,(5) and Reil,(6) state the same distribution as ourselves : this arrangement then should be regarded as the most constant.

b. Tibial nerve.

§ 1825. The *tibial* or *internal popliteal* nerve (*N. tibialis*), the largest and most internal of the two terminating branches of the sciatic nerve, may be called the *popliteal* (*N. popliteus*), from the bifurcation to the calf of the leg, although this term is not perfectly exact. It gives off first a considerable cutaneous nerve, the *long posterior cutaneous nerve of the foot and the leg*, or rather the *external cutaneous tibial nerve of the foot* (*N. cutaneus longus posterior tibiæ*, s. *cutaneus pedis externus*, s. *tibialis*), which nevertheless often comes from the peroneal nerve, or at least especially when the sciatic nerve bifurcates high up, is partially replaced either by the posterior and inferior branch of this latter, or even by its inferior and middle cutaneous nerve.

(1) Sœmmerring, *Hirn-und Nervenlehre*, p. 312.
(2) *Neurologia*, p. 203.
(3) Sœmmerring, *Nervenlehre*, p. 309.
(4) *Tr. complet d'anat.* ed. 3. vol. iii. p. 328.
(5) *Neurologia*, p. 201, 203.
(6) *Anat. descript.* vol. iii. p. 309.

The external cutaneous tibial nerve of the foot descends behind the muscles of the foot, goes outward below the external malleolus, proceeds along the external edge of the foot and the fibular edge of the fifth toe, constituting its dorsal peroneal nerve, and proceeds to the top of it.

The tibial nerve then gives off a small branch to the posterior part of the capsule of the articulation of the knee. This branch is sometimes given off higher or as high as the preceding.

Farther on, the trunk of the tibial nerve gives external and internal branches to the three heads of the triceps, the plantaris, the popliteus, the tibialis posticus, and the flexor hallucis longus.

§ 1826. The tibial nerve then goes forward between the upper two heads of the triceps suræ muscle, descends between the tendo achillis, the tibialis posticus and the flexor hallucis longus, passes behind the malleolus internus, and goes to the sole of the foot.

Behind the malleolus it divides into three branches, one superficial and two deep.

§ 1827. The superficial branch or the *external tibial* nerve (*N. tibialis exterior*), more properly the *proper cutaneous plantar* nerve (*N. cutaneus plantaris proprius*), is distributed to the skin below the malleolus internus, and at the posterior part of the sole of the foot.

§ 1828. The two deep branches are the *internal* and the *external plantar* nerve.

The *internal plantar* nerve (*N. plantaris internus*) is usually a little larger and more superficial than the other ; it goes forward under the long head of the adductor hallucis, between it and the flexor communis digitorum brevis, and divides far back into two branches, an internal and an external: the latter is the larger.

The internal branch having given filaments to the adductor hallucis, becomes the *first plantar nerve of the toes* (*N. digitorum plantaris primus*), the *tibio-plantar* nerve or the *internal nerve of the great toe* (*N. plantaris internus*, s. *tibialis hallucis*).

The external branch also subdivides into two others, the external of which is also the larger.

The internal or the *third plantar nerve of the toes* also divides into the *external plantar nerve of the second toe*, and the *internal plantar nerve of the third toe.*

The external or the *fourth plantar nerve of the toes* divides into the *external plantar nerve of the third toe*, and the *internal plantar nerve of the fourth.*

Thus this trunk distributes its branches to the internal half of the skin of the foot, to the two sides of the three internal toes, and to the internal side of the fourth.

§ 1829. The *external plantar* nerve (*N. plantaris externus*) goes forward and outward between the flexor communis digitorum brevis, and the tendon of the flexor longus, and divides before the tuberosity of the calcaneum into three branches.

The internal branch, the *fifth plantar nerve of the toes*, which is entirely cutaneous, goes forward to the anterior extremity of the tarsus, where it divides into the *plantar nerve of the fourth toe*, and the *internal plantar nerve of the fifth*.

The external branch, the *musculo-cutaneous* nerve, goes forward along the fibular edge of the sole of the foot, gives filaments to the abductor minimi digiti muscle, and becoming the *external plantar nerve of the fifth toe*, advances to its extremity, where as in the great toe, it receives at its external edge a distinct branch, an arrangement which is worthy of notice, as it contributes to the lateral symmetry.

This nerve forms the *sixth plantar nerve of the toes.*

The middle, deep, or muscular trunk is the largest. It goes obliquely inward and forward, penetrates between the tendons of the extensor longus digitorum communis and the deep muscles of the sole of the foot, and distributes itself in the lumbricales, the adductor and flexor hallucis muscles, and in almost all the internal part of the interossei muscles, and the small muscles of the fifth toe.

ARTICLE THIRD.

OF THE CERVICAL NERVES.

§ 1830. Till the time of Willis, eight *cervical* nerves, *tracheliens* Ch. (*N. cervicales*, s. *N. colli*)(1) were admitted, but this anatomist and many after him, have mentioned only seven ; as they consider the first cervical as the last encephalic nerve, an opinion less correct than the ancient. The general characters of these eight nerves are :

1st. Of all the spinal nerves they have the least extent in the vertebral column from their origin to the place where they penetrate the dura-mater, and emerge through the intervertebral foramina.

2d. The internal extremities of their roots are closer to each other than those of the thoracic nerves, but farther than those of the lumbar and sacral nerves.

3d. The different pairs are united together by anastomoses ; these are usually simple, and extend from the inferior edge of the root of the superior nerve, to the upper edge of that of the lower nerve, and form the upper part of this last. The anastomosing filaments of the posterior roots are more constant than those of the anterior ; the latter usually exist only between the second and third pairs, and the third and fourth, and are deficient between all the others. On the contrary, the anastomosing filaments of the anterior roots exist in almost every part, but are sometimes deficient between the lower pairs. They are very seldom met with between the last cervical and the first dorsal nerve.

We, however, should observe that the anastomosing filaments often do not exist between the middle cervical pairs, although found between the superior and the inferior nerves.

(1) J. Bang, *Nervorum cervicalium anatome ;* in Ludwig, Se. neur.

The arrangement of these filaments is not always exactly the same; we usually see a filament which goes a little obliquely upward and outward from the internal extremity of the upper edge of the lower nerve, towards the external extremity of the lower edge of the upper nerve. But sometimes this filament descends directly from the lower edge of the upper nerve, to the upper edge of the lower nerve.

Between this arrangement and the preceding is one which is intermediate, where the most superior fasciculus of the lower nerve divides at its centre into two parts, the upper of which goes to the upper nerve in the first of the two modes mentioned above, while the lower proceeds in the direction of the fasciculus, forming the most upper part of the lower nerve. Sometimes one or two thin fasciculi are found between two pairs of nerves, and usually a little nearer the lower than the upper. When there is only one fasciculus, this divides into two; when two, they arise immediately one at the side of the other. In both cases either the fasciculi primitively distinct, or the two branches of the single fasciculus separate from below upward immediately after arising, and form, one the most inferior fasciculus, the other the most superior of the pairs between which they are situated. Sometimes they are united together by superior and inferior fasciculi, and afterward by a transverse filament.

The first arrangement usually exists between the inferior cervical nerves, the third between the middle, the second between the superior, and the fourth between the first two, counting from above downward.

The cervical nerves may be divided into two groups; the first comprises the four lower pairs, the other the four upper pairs, for the first differ much from the second, as they enlarge to give origin to the nerves of the upper extremities.

A. INFERIOR CERVICAL NERVES AND FIRST DORSAL NERVE, OR NERVES OF THE UPPER EXTREMITIES.

§ 1831. The *nerves of the upper extremities* (*N. brachiales*, s. *extremitatis superioris*)(1) arise from the first dorsal and the four inferior cervical nerves, which unite at some distance from their foramina to form the brachial plexus, so that a greater number of trunks comes afterward from the latter, each of which is formed from the fasciculi coming from several of the carrying nerves. The first dorsal nerve emerges below the first dorsal vertebra, the eighth cervical below the seventh cervical vertebra, the seventh below the sixth, the sixth below the fifth, and the fifth below the fourth. That nerve which usually occupies the centre of the group, that is the seventh cervical nerve, is the largest: the first dorsal and the fifth cervical nerves are the smallest: the fifth cervical nerve is smaller than the first dorsal, and the sixth and eighth dorsal are about the same size.

(1) J. J. Klint, *De nervis brachii*, Gottingen, 1784.— P. Camper, *Demonst. anat. pathol.*, l. i. Amsterdam, 1760.

The nerves which usually emerge from the brachial plexus are the *thoracic*, the *scapular*, the *axillary*, the *radial*, the *external cutaneous*, the *median*, the *ulnar*, and the *internal cutaneous* nerves.

§ 1832. Before uniting, the five nerves which form the brachial plexus give off much smaller posterior branches, which go to the deep dorsal muscles of this region. The brachial nerves are then only the enlarged anterior branches of the superior dorsal and the four inferior cervical nerves.

§ 1833. These anterior branches descend from within outward, pass between the scalenus anticus and medius muscles, and soon unite to form the *brachial plexus* (*plexus brachialis*).(1) The two superior and two inferior usually unite before the middle with the adjacent branches.

The fifth and the sixth usually unite the first.

Two nerves arise from their union.

The superior after passing several inches divides into two branches, one of which is the *axillary* or *circumflex* nerve, the other is large and unites with the large posterior fasciculi of the seventh and eighth cervical nerves to form the radial nerve.

The inferior, having procceded two or threc inches, unites with one or two anterior fasciculi of the seventh cervical nerve, and thus produces a more or less complicated plexus, whence the external cutaneous or the musculo-cutaneous nerve wholly, and the median partially arise.

The seventh cervical nerve divides two or three inches from its emerging from the spinal canal into an anterior and a posterior branch, of which the second is larger.

The posterior branch blends with the upper posterior branch of the eighth cervical nerve in a small trunk, which soon joins the posterior branch of the trunk formed by the union of the fifth and sixth cervical nerves, and gives origin to the radial nerve.

From the anterior branch and the common trunk formed by the union of the fifth and sixth cervical nerves, several anterior thoracic nerves arise and then the musculo-cutaneous nerve; it gives rise with the eighth cervical and the first dorsal nerves to the median nerve.

The eighth cervical nerve divides into two branches, one posterior, thinner but longer, the other anterior, shorter but much thicker.

The posterior unites to some branches of the fifth, sixth, and seventh cervical nerves to form the radial nerve.

The anterior joins the first dorsal nerve.

The common trunk formed by this last union, divides into two branches, a superior and an inferior.

The superior, united with the fasciculi of the fifth, sixth, and seventh cervical nerves, becomes the median nerve.

The inferior forms the ulnar nerve.

The first dorsal nerve divides into two other branches, both of which unite with the eighth cervical nerve.

(1) Bang (*loc. cit.*) has figured the brachial plexus—Prochaska *De struct. nerv.*, Vienna, 1779, tab. iv. v.—Scarpa, *Annot. anat.*, B. 1. lab. fi.

The superior assists to produce the radial nerve.

The inferior concurs to form the ulnar nerve, and sometimes alone produces the internal cutaneous nerve.

I. THORACIC NERVES.

§ 1834. The *thoracic nerves*, *sterno-thoraciques*, Ch. (*N. thoracici*) may be distinguished into *posterior* and *anterior*.

The *posterior* arise from the branches of the fifth and sixth, sometimes also from the seventh cervical nerve, which are mostly united in a nerve which descends on the external face of the serratus major muscle, and is distributed in that muscle.

The *anterior* arise from the anterior trunk formed by the union of the fifth and sixth cervical nerves, and also from the anterior branch of the seventh and eighth, descend from behind forward, and give filaments to the subclavius, the pectoralis major and minor muscles, the thymous gland, and the skin of the anterior and superior part of the chest and shoulder, where they anastomose with some filaments of the fourth cervical and axillary nerves.

II. SCAPULAR NERVE.

§ 1835. The *scapular* nerve (*N. scapularis*), which is rather large often comes from the fifth cervical nerve before it joins with the following. When it arises only after the union, it commences almost in the place where it is, passes through the coracoid notch of the scapula, arrives thus on the posterior face of the scapula, sends filaments to the supraspinatus muscle, goes downward over the neck of the scapula, and arrives at the infraspinal fossa, where it is distributed to the infraspinatus and teres minor muscles.

III. AXILLARY NERVE.

§ 1836. The *axillary* nerve, *scapulo-humeral*, Ch. (*N. axillaris*, s. *circumflexus brachii*), or more properly the circumflex nerve, arises from the posterior and superior branch coming from the division of the common trunk formed by the union of the fifth and sixth cervical nerves. It first sends branches to the infraspinatus muscle, which often receives a large one from the common trunk mentioned above, it then gives some to the teres minor and major muscles, then passing between these two muscles and the long head of the triceps extensor, it is reflected outward and backward on the head of the humerus, expands in the deltoides muscle, and finally becoming the *cutaneous nerve of the shoulder* (*N. cutaneus humeri*), together with the fourth cervical nerve sends filaments to the integuments of this region.

IV. RADIAL NERVE.

§ 1837. The *radial* nerve, *radio-digital*, Ch. (*N. radialis*), is much larger than the preceding, arises from fasciculi of all the brachial nerves by three branches, which come one from the seventh cervical nerve only, the second from the fifth and sixth, and the third from the eighth cervical and the first dorsal nerves. Soon after its origin, it gives a large branch to the latissimus dorsi and filaments to the triceps extensor muscles. A little below the middle of the arm it turns on the humerus, often reappearing on its anterior face between the brachialis internus and the supinator longus muscles.

In turning on the humerus it gives a long and thin cutaneous branch, the *superior external cutaneous* nerve (*N. cutaneus externus superior*). This nerve descends along the radial edge and the inner face of the fore-arm, and interlaces with the cutaneous branch of the musculo-cutaneous nerve, extends a greater or less distance to the middle of the fore-arm, to the carpus, and even the thumb.

The trunk of the radial nerve then gives branches to the supinator longus and the extensor carpi longus radialis muscles. It divides at the lower extremity of the fore-arm into two branches, a superficial or cutaneous and a deep or muscular.

The *superficial* branch (*R. superficialis dorsalis*, s. *cutaneus*) descends along the anterior edge of the radius between the supinator longus and the radiales muscles, arrives at the outer face of the fore-arm, passing below the tendons of the first of these three muscles, and divides usually some inches below the inferior extremity of the fore-arm into two almost equal branches, the anterior being a little the larger, which distribute filaments to the anterior region of the integuments of the back of the hand, and to the dorsal face of the three anterior fingers.

The *anterior* branch anastomoses in several places with those of the cutaneous branch of the musculo-cutaneous nerve, sends filaments to the skin of the radial side of the carpus and metacarpus, and divides on the carpus into two small branches, the *dorsal nerves of the thumb* (*N. cutanei pollicis dorsales*), which descend on its dorsal side along the radial and ulnar edges to its anterior extremity, furnish filaments to its dorsal face, and anastomose together and with the palmar nerves of the thumb.

The *posterior* branch usually divides soon after arising into two principal ramuscules, an anterior and posterior.

The anterior goes to the skin between the thumb and index finger, and arrived at the radial side of the last finger becomes the *radio-dorsal nerve of the index finger* (*N. dorsalis radialis indicus*).

The posterior soon subdivides into two filaments, one of which produces the *cubito-dorsal nerve of the index finger* and the *radio-dorsal nerve of the middle finger*, while the second is the *cubito-dorsal nerve of the middle finger*.

All these ramifications frequently anastomose with each other or with those of the ulnar nerve, and thus give rise to a plexus called the *dorsal arch of the hand* (*rete*, s. *arcus dorsalis manus*).

The deeper or larger muscular branch gives off branches for the radialis brevis and the supinator brevis muscles; it then turns over these muscles and engages itself between their fibres, penetrates between the extensor digitorum communis muscle, arrives at the posterior surface of the fore-arm, gives off some large branches, some of which are recurrent to the extensor digitorum communis, to the extensor minimi digiti, and to the ulnaris internus and externus muscles. Then as the *external interosseus* nerve (*N. interosseous externus*), it descends on the extensor and the adductor pollicis longus muscles, to which it sends filaments, as also to the extensor indicis proprius muscle, and is finally lost in the capsule of the wrist-joint.

V. EXTERNAL CUTANEOUS NERVE.

§ 1838. The *external cutaneous* nerve, or *musculo-cutaneous* nerve, or the *perforating nerve of Casserius*, *radio-cutané*, Ch. (*N. cutaneus externus*, s. *musculo-cutaneus*, s. *perforans Casserii*), is much smaller than the preceding, although it descends almost as low as it. It arises from the fasciculi of the fifth, sixth, and seventh cervical nerves. It sometimes comes from the median nerve.

It frequently but not always penetrates the coraco-brachialis muscle. When this is not the case, it passes on the internal edge of this muscle, being joined to it only at its surface. It divides high up in the arm into two branches, the one muscular and small, the other cutaneous and larger.

The muscular branch gives filaments to the coraco-brachialis muscle, to the two heads of the biceps, and to the brachialis internus muscle.

The *cutaneous* branch passing between the biceps and the brachialis internus muscle, arrives at the anterior edge of the arm, descends on the radial side in the aponeurosis, accompanying the cephalic vein. It anastomoses frequently above with the external cutaneous nerve, and below with the dorsal branch of the radial nerve; it is distributed to the skin of the posterior surface of the fore-arm and the hand, and terminates at the thumb.

VI. MEDIAN NERVE.

§ 1839. The *median* nerve, *médio-digital*, Ch. (*N. medianus*), the largest nerve of the upper extremity, comes also from the brachial plexus. It descends on the inside of the arm near its lower extremity without giving off any branch, unless it be sometimes the external cutaneous nerve.

Some inches below the elbow-joint it gives several small muscular branches to the pronator teres, to the upper part of the radialis internus, the palmaris longus, and to the upper part of the flexor digitorum brevis muscles. Near the elbow it gives off a considerable branch, the *internal interrosseus* nerve (*N. interrosseus internus*), which descends before the flexor communis digitorum profundus, distributes branches to this muscle and to the flexor pollicis longus, is reflected on the anterior edge of the pronator quadratus, arrived thus at the posterior face of the fore-arm, it terminates in this muscle.

The trunk descends before the flexor digitorum profundus, between the bones of the fore-arm, gives off filaments to this muscle and to the palmaris longus, and gives a cutaneous branch which is distributed in the integuments of the palmar face of the carpus, where it anastomoses with the branches of the musculo-cutaneous nerve and the ulnar nerve. It then divides near the lower third of the fore-arm into two branches, an anterior or radial and a posterior or ulnar ; the first is the larger.

These branches descend without giving any twig to the fore-arm between the tendons of the flexors, with which they pass under the ligaments of the carpus, where they usually unite by some transverse fibres. At the palm of the hand they separate.

The radial branch divides at the carpus into an anterior and posterior twig.

The anterior very soon divides into three filaments, the *radio-palmar* and the *cubito-palmar nerves of the thumb*, and the *radio-palmar nerve of the index finger*, these frequently anastomose together, extend to the extremities of these two fingers, and terminate by considerable branches, and give filaments to the first lumbricalis muscle.

The posterior then sends a large branch to the adductor brevis, to its opponens muscle and the flexor pollicis brevis, after which it becomes the *cubito-palmar nerve of the index finger*.

§ 1840. The cubital branch divides at the commencement of the carpus into two twigs.

The anterior which is smaller sends filaments to the second lumbricalis muscle, and becomes the *radio-palmar nerve of the third finger*.

The posterior which is larger sends filaments to the integuments of the hand, soon divides into two ramuscules, the *cubito-palmar nerve of the third finger* and the *radio-palmar nerve of the fourth*.

VII. ULNAR OR CUBITAL NERVE.

§ 1841. The *ulnar* nerve, *cubito-digital* (*N. ulnaris*, s. *cubitalis*), is a little smaller than the preceding, and arises from the three inferior nerves of the brachial plexus. It descends inward and backward, gives off no branches along the arm except sometimes the internal cutaneous nerve, and arrives at the ulnar side of the fore-arm, passing imme-

diately behind the internal condyle of the humerus, where it may be easily compressed.

Arrived at the fore-arm, it first gives off ramifications to the flexor digitorum profundus and to the flexor carpi ulnaris, and then sends under the skin along the basilic vein a small branch, called the *long palmar* nerve (*N. ulnaris longus palmaris*), which anastomoses in the carpus with an analogous branch coming from the median nerve; about the middle of the fore-arm, it divides into two branches, a dorsal and a palmar.

The dorsal branch (*N. ulnaris dorsalis*) passes between the ulna and the tendon of the flexor carpi ulnaris muscle, comes on the back of the fore-arm, where it subdivides into two twigs.

The posterior or ulnar supplies the skin of the ulnar side of the hand, and becomes the *cubito-dorsal nerve of the fifth finger*.

The anterior or the radial also soon divides into two principal filaments, one of which is the *radio-dorsal nerve of the fifth finger* and the *cubito-dorsal nerve of the fourth*, the other is the *radio-dorsal nerve of the fourth finger*.

This dorsal branch is distributed like the dorsal branch of the radial nerve.

The palmar branch (*N. ulnaris palmaris*) which is larger, descends between the tendons of the ulnaris internus and the flexor digitorum communis muscles, and divides on the ulnar edge of the carpus into a superficial and a deep twig.

The deep or muscular twig goes downward and forward between the adductor and flexor minimi digiti muscles, passes across to the radial side of the hand, going between the tendons of the flexor communis and interossei muscles, and sends numerous twigs to the muscles of the little finger, to the interossei and lumbricales, and to the adductor pollicis muscles.

The superficial or cutaneous branch is smaller than the preceding, anastomoses by one or several filaments with the cubito-palmar branch of the median nerve (from this union we have a superficial palmar arch), and soon divides into two filaments, an anterior and a posterior.

The anterior soon divides into the *cubito-palmar nerve of the fifth finger* and the common trunk of the *cubito-palmar nerve of the fourth*, and the *radio palmar nerve of the fifth*.

Each finger receives two palmar and two dorsal branches, the first of which are the largest. They proceed along the radial and ulnar edges of the finger directly at the side of the digito-palmar artery, more inward and downward than it, that is, nearer the palmar face, as likewise the superficial palmar arch is nearer the surface than their trunk. They go to the extremity of the fingers. In this passage they give off several large branches, distribute some small twigs to the palmar face of the finger, when they anastomose with each other.

VIII. INTERNAL CUTANEOUS NERVE.

§ 1842. The *internal cutuneous* nerve, *cubito-cutané*, Ch. (*N. cutaneus internus*), usually arises from the first dorsal by several roots; it sometimes though rarely comes from the ulnar, being the first branch. It descends directly below the skin at the side of the basilic vein in the arm. From its upper part arises the *superior cutaneous* nerve (*N. cutaneus internus superior*), which sometimes comes from the ulnar nerve, and is distributed to the triceps extensor muscle and the skin which covers it. A little lower it gives off the *inferior internal cutaneous* nerve (*N. cutaneus internus inferior*), which distributes its branches to the lower part of the triceps extensor muscle, to the skin of the elbow, to the integuments of the ulnar edge of the fore-arm, and to the carpus, and which terminates on the cubital edge of the hand and little finger, descending along the basilic vein, and anastomosing with the branches of the ulnar nerve, which it meets in its course.

In the whole course of this nerve its different branches anastomose frequently with each other and with those of the external cutaneous nerve on the posterior side of the fore-arm.

B. SUPERIOR CERVICAL NERVES.

§ 1843. The four superior cervical nerves are smaller than the inferior. Like the latter their size increases progressively from above downward, so that the second and third are the largest. They form with the lower ones an uninterrupted series; and like them their anterior branches immediately after their trunks have come from the intervertebral foramina, give off twigs which anastomose with the adjacent branches and form the cervical *plexus*, *trachélo-sous-cutané*, Ch. (*plexus cervicalis*). This plexus descends along the corresponding vertebræ, below the sterno-cleido-mastoideus muscle, outside of the internal jugular vein, carotid artery, and pneumogastric nerve, on the scalenus posticus muscle. It anastomoses below with the brachial plexus, within with the superior and middle cervical ganglions of the great sympathetic nerve. We have as much reason to think the different branches of the cervical nerves are derived from them as that they arise from the cervical pairs themselves.

Some modern anatomists, among whom are Bichat(1) and Cloquet,(2) have adopted this method, and describe separately only the posterior branches and the commencement of the anterior, and consider the cervical plexus as the origin of all the nerves which arise after the union of the anterior branches. But we shall not follow them, as the

(1) *Anat. descript.*, vol. iii. p. 234–246.
(2) *Tr. d'anat.*, vol. ii. p. 633–641.

nerves of which they treat seem to arise from some particular pairs which are not seen in the other plexiform nerves of the spinal marrow.

The diaphragmatic nerve is the only one to be considered separately, because produced not only by several pairs of the cervical plexus but also of the brachial plexus, so that it seems to belong in common to the superior and inferior section of the cervical nerves.

I. DIAPHRAGMATIC NERVE.

§ 1844. The *diaphragmatic* or *phrenic* nerve (*N. diaphragmaticus*, s. *phrenicus*)(1) arises by several branches from the lower extremity of the brachial plexus. The largest branch is always furnished by the anterior branch of the fourth pair, but a smaller one always arises from the third and often from the second, and about three from the brachial plexus. This nerve sometimes joins the ascending branch of the hypoglossal nerve.

The diaphragmatic nerve descends on the side of the neck between the rectus capitis anticus and the scalenus muscle, gives branches to these muscles and to the thymous gland, anastomoses by a few filaments with the inferior and middle cervical ganglions of the great sympathetic nerve, enters the chest between the subclavian artery and vein, then goes forward, descends before the pulmonary vessels, and lastly passes between the internal wall of the external sac of the pleura and the pericardium, applied very exactly to the surface of this last membrane, and is finally distributed to the diaphragm. A little before arriving at this muscle, it divides into several branches which are united by intermediate filaments, some of which go to the convex face of the diaphragm and others pass through its costal portion and its central tendon, accompany the ascending vena-cava on the right, with which they emerge through the foramen quadratum, come into the abdomen, where they not only expand on the inferior face of the muscle, but also anastomose by several filaments with the solar plexus of the great sympathetic and with the gastric branch of the pneumo-gastric nerve. These anastomotic filaments almost always project at intervals, and these projections often form real ganglions.

The left diaphragmatic nerve is situated farther back, and is longer than the right, as it turns around on the summit of the heart. Besides the filaments it gives to the diaphragm, it sends some also to the lower part of the esophagus.

(1) Kruger, *De nervo phrenico*, Leipsic, 1758.

II. FOURTH CERVICAL NERVE.

§ 1845. The *fourth cervical* nerve(1) is a little smaller than the two adjacent. It emerges through the third intervertebral foramen, between the anterior and posterior intertransversarii muscles, and immediately divides into an anterior and a posterior branch.

The *posterior* is the smaller and deeper: it anastomoses with a branch of the third cervical nerve, gives a twig to the complexus muscle, passes transversely between this muscle and the semispinalis colli, to which also it sends large filaments, also to the multifidus spinæ, then penetrates between the complexus and trapezius muscles, and expands in the corresponding skin of the neck.

The *anterior* branch, which is the larger, first gives off a filament to the rectus capitis major anticus muscle: then it sends one of anastomosis to the cervical portion of the great sympathetic nerve, or to its superior cervical ganglion. It usually gives off also a twig to the descending branch of the hypoglossal nerve, and constantly sends filaments to the levator anguli scapulæ muscle.

It then sends an ascending anastomotic twig to the anterior branch of the third cervical, and forms with it the *third cervical nervous plexus*, then divides into three or four twigs which also proceed from above downward, and are called the *supraclavicular* nerves (*N. supra-clavi-culares*). The latter are distributed principally to the skin which covers the clavicle and the shoulder.

The *anterior* (*N. supra-claviculares anteriores*) are distributed to the skin which covers the first piece of the sternum and the sternal extremity of the clavicle to the mamma, anastomose with the anterior thoracic nerves coming from the fifth cervical, and send filaments also to the subclavius muscle.

The *middle* (*N. supra-claviculares medii*) are distributed to the trapezius muscle and the posterior belly of the omo-hyoideus muscle, and also to the skin which covers the body of the clavicle, its scapular extremity, and the scapula.

The *posterior* (*N. supra-claviculares posteriores*) go to the skin of the neck and of the shoulder.

A small ascending branch generally arises from the anterior or the middle nerve; this forms a very broad plexus by anastomosing with the middle subcutaneous cervical nerve, which comes from the third pair.

The middle and the posterior anastomose with the accessory nerve partly in the skin, and partly in the trapezius muscle.

(1) G. F. Peipers, *Diss. sistens tertii et quarti nervorum cervicalium descriptionem, cui accedit succincta eorundem nervorum quinti, nervi phrenici, præsertim ratione originis nervi duri ejusque præsertim rami inferioris, nervi hypoglossi et occipitalis maximi a secundo cervicalium nervo adumbratio*, Halle, 1793.

III. THIRD CERVICAL NERVE.

§ 1846. The *third cervical nerve*(1) is larger than the preceding. It emerges from the spinal canal between the second and the third cervical vertebræ, and divides into two branches, a posterior and an anterior.

The *posterior* branch is much smaller than the anterior; it proceeds from before backward between the anterior and posterior intertransversarii muscles, gives filaments to these two muscles and also to the transversalis colli and the complexus minor muscles, goes backward passing on this latter, sends anastomosing filaments to the posterior branch of the second and third cervical nerves, and also to the small occipital nerve which comes from the anterior branch of the third pair, glides below the biventer cervicis nuchæ and the complexus major muscles, which receive considerable filaments from it, and goes directly to the trapezius muscle in which it is distributed, and also in the middle region of the skin of the neck.

The *anterior* branch sends first small twigs to the rectus capitis major anticus and to the longus colli muscles, then proceeds from above downward and divides into two branches, a descending and an ascending.

The *descending* branch, the *superficial cervical* nerve, the *submental* nerve, Ch. (*N. superficialis colli*, s. *profundus*, *N. sub-cutaneus colli medius*) turns on the posterior edge of the sterno-cleido-mastoideus muscle, to go to the outer face of this muscle, to which it gives filaments, sends others which anastomose with the ascending branch, and terminates first, by descending ramifications called the *middle* and *inferior subcutaneous cervical* nerves (*N. subcutanei colli medii et inferiores*), in the middle and lower part of the skin of the neck; second, by ascending twigs which anastomose frequently, both with each other and with the final twigs of the facial nerve in the skin which covers the ascending and horizontal branches of the lower jaw from the lobe of the ear to the chin, and thus form the *superior subcutaneous cervical* nerves (*N. subcutanei colli superiores*).

The highest and most posterior portion of this descending branch, or the *great auricular* nerve, the *zygomato-auricular* nerve, Ch. (*N. auricularis magnus*, s. *cervicalis*), goes directly upward, and passing behind the ascending branch of the lower jaw arrives at the external ear. Its ramifications are distributed from behind forward and from below upward in the integuments and posterior muscles of the external ear, and also in the skin of the auditory foramen.

The *ascending* branch goes backward and upward, gives off first an ascending anastomosing filament which unites to a descending filament of the third pair to form the *second cervical nervous plexus*, and often sends off immediately the great auricular nerve. In this case its pos-

(1) Peipers, *loc. cit.*—Vic-d'Azyr, *Mémoiré sur les nerfs de la seconde et de la troiséme paire cervicale*; in the *Mém. de Paris*, 1777, p. 21–40.

terior part, and when the great auricular nerve comes from the descending branch, its entire trunk becomes the *small* or the *anterior occipital* nerve (*N. occipitalis minor*, s. *anterior*), which most generally soon divides into several filaments, ascends on the complexus minor and splenius capitis muscles and expands in the skin of the occiput, in that of the mastoid process, in that of the posterior and superior part of the external ear between the superior and posterior auricular muscles, farther forward than the large occipital nerve given off by the second cervical pair, although anastomosing frequently with this latter, as with the filaments of the facial nerve.

IV. SECOND CERVICAL NERVE.

§ 1847. The *second cervical* nerve(1) emerges from the spinal canal between the first and second cervical vertebræ. It is larger than the third, and divides into an anterior and a posterior branch, directly below the ganglion.

The *posterior* branch, the *great occipital* nerve (*N. occipitalis maximus*), is much larger than the anterior, which is contrary to the arrangement of the inferior cervical nerves except the first, and to that of all the other spinal nerves. It goes directly backward below the complexus minor muscle, first sends filaments to the obliquus capitis inferior muscle, gives off others which pass on this muscle to anastomose with the first and third cervical nerves, also gives them to the upper part of the two splenii muscles, to the biventer cervicis, the complexus and trapezius muscles under which it proceeds, to the multifidus spinæ and to the skin of the neck, approaches the median line, and arrives at the occipital bone ; it there forms most of the nerves in this region, ramifies to the lambdoidal suture, where its filaments expand in the skin and occipitalis muscle, and anastomose with those of the facial and small occipital nerve.

The *anterior* branch is smaller than the preceding ; it goes forward and outward under the obliquus capitis superior muscle, and soon divides into two anastomotic branches, a superior, *ascending* (*N. anastomoticus adscendens*), and an inferior, *descending* (*N. anastomoticus descendens*), which unite, the first with the anterior branch of the first cervical nerve, to form the *first cervical nervous plexus ;* the other with the anterior branch of the third, to form the *second cervical nervous plexus.*

From the upper branch arise filaments which enter the superior cervical ganglion of the great sympathetic, the sublingual, and the pneumo-gastric nerve: one arises even from the bifurcation and goes into the superior cervical ganglion ; finally the inferior branch produces one which is larger, which descends from behind forward and anastomoses with a similar twig from the anterior branch of the third cervical nerve, and with the descending branch of the sublingual nerve.

(1) Vicq-d'Azyr, *loc. cit.*

V. FIRST CERVICAL NERVE.

§ 1848. The *first cervical* nerve, called also the *suboccipital* or the *tenth encephalic* nerve (*N. cervicalis primus*, s. *supremus*, s. *occipitalis*, s. *infra-occipitalis*, s. *decimus cerebri*),(1) is frequently the smallest of all the spinal nerves, since it is not unfrequently smaller than the last sacral nerve; at least it is always smaller than the other nerves of the spinal marrow, except the last. By its situation, origin, and direction, it makes the transition from the spinal to the encephalic nerves, for it frequently in the same and still more so in different subjects resembles the former in some characters, the latter in others.

Hence for a long time, that is, since Willis lived, it has been considered as an encephalic nerve, the tenth cerebral nerve. It is not till lately that it has been generally admitted among the spinal nerves, to which it is more similar than to the cerebral nerves.

It arises out of the skull from the upper extremity of the spinal marrow between the occipital portion of the basilar bone and the first cervical vertebra.

Very often, perhaps even most generally, although Huber considers the existence of two roots as a constant fact,(2) it arises by one anterior root which, like that of the sublingual nerve, comes from the anterior cord of the spinal marrow.(3)

Even when a posterior root exists, the anterior is much larger than it, and is composed of from two or three to seven fasciculi, rarely of eight, more commonly of two or three. These fasciculi, situated one above another, are also formed of smaller filaments. The posterior root presents only from one to three, and rarely four filaments which are much smaller, the inferior of which, a remarkable fact, is generally much larger than the others: these filaments commonly unite in two fasciculi which proceed the superior outward, the inferior upward.

Even when the posterior root exists, the nerve however is most generally formed anteriorly by but one root, the anterior, for the latter ascends more than the posterior.

The posterior root is generally situated behind the accessory nerve; sometimes, however, but very rarely (we have never observed it), it passes before. It is then in this latter case unusually near the anterior, although the ligamentum denticulatum even then always separates it from them. Farther it is constantly nearer the anterior face than are the posterior roots of the other spinal nerves.

(1) G. T. Asch, *De primo pare nervorum medullæ spinalis*, Gottingen, 1750.—Sabatier, *Sur les nerfs de la dixième paire;* in the *Mém. présentés*, vol. vit., p. 553.

(2) *De medullâ spinali*, Gottingen, 1741, § 12.

(3) Morgagni (*Ep. anat.*, vol. xvi. 8vo.) also says: *Septies ab eo tempore ex quo semel anteriores tantam reperi, posteriores illas fibras quæsivi. Bis dubius hæsi. Quater procul omni dubio nullas omnino fuisse deprehendi. Semel a dextris.... sed ne in eo quidem ipso.... ullam prorsus fibram e sinistris.*—See also Vicq-d'Azyr, *Mém. de Paris*, 1781, p. 596.—Gordon, p. 214.—Cloquet, p. 631.

The posterior root most generally anastomoses with the accessory nerve. This is sometimes, although more rarely, the case with the anterior. Sometimes the posterior does not unite with the anterior; it goes only to the accessory nerve, in which case the latter after forming a small ganglion which however does not constantly exist, sends one or two filaments to the anterior root of the second cervical nerve.

Sometimes instead of the posterior root we find only a plexus which anastomoses with the accessory nerve, the filaments of which go towards the opening destined for the passage of the first cervical nerve.(1).

When the posterior root and the accessory nerve do not anastomose, we generally find a filament which extends from this root to the posterior root of the second cervical nerve; but this filament is not constant.

The direction of the first cervical nerve is most generally transverse from its origin to its emerging from the spinal canal. It not unfrequently proceeds in a direction opposite to that of the other cervical nerves, that is, it proceeds a little more from below upward and from within outward like the cerebral nerves.

The superior filaments of the posterior root rarely go upward, and the inferior downward. Still more rarely the inferior filaments of the two roots have a direction from above downward, while on the contrary the superior commonly follow this direction.

It is easy to observe that the smallness, the frequent absence and the anterior situation of the posterior root, its separation from the anterior, the anastomosis of the latter with the accessory or the second cervical nerve, and the direction of the whole nerve, establish a great analogy between the latter and the cerebral nerves, while the frequent existence also of the roots and their place of origin, establish a resemblance with the spinal nerves.

§ 1849. The trunk of the first cervical nerve passes between the occipital portion of the basilar bone and the transverse process of the atlas, in the lateral groove of the vertebra below the vertebral artery, after forming a very elongated, more or less apparent, and often almost imperceptible ganglion. It divides, as usual, opposite the posterior edge of the atlas into an anterior and a posterior branch.

The *posterior* is larger, and proceeds obliquely backward and upward, and divides into seven or eight radiating filaments which go to the obliquus capitis minor, the obliquus capitis major, the rectus capitis major and minor, and the complexus muscles. Some penetrate within the mastoid process.

The *anterior* is smaller, goes first from behind forward along the vertebral artery to the place where this vessel leaves the vertebral canal, it then immediately ascends between the transverse process of

(1) Vicq-d'Azyr, *loc. cit.*, p. 296.

the atlas and the mastoid process. It then divides into four or five branches.

The first turns around on the transverse process of the atlas, proceeding from above downward, and anastomoses with one or two ascending filaments of the anterior branch of the second pair. It gives off some filaments which unite with the pneumo-gastric, the hypoglossal, and the great sympathetic nerve.

The second goes to the temporalis muscle.

The third enters the vertebral canal, is distributed to the vertebral artery, and sends filaments to the second cervical nerve.

The fourth and fifth arise before the transverse process of the first cervical vertebra, and are distributed in the rectus capitis major and minor muscles.

The peculiarity in the distribution of this nerve, is, that being situated very deeply, it sends off filaments only to these muscles and these vessels, and does not extend to the skin.

CHAPTER II.

ENCEPHALIC NERVES.

§ 1850. The following are usually mentioned as general characters of the *encephalic* nerves(1) to distinguish them from the spinal nerves.

1st. They arise by a single root.

2d. On leaving the dura-mater they do not produce any special ganglion without the concurrence of another nerve.

3d. They pass through foramina in the bones of the skull, or through very irregular fissures formed in them.

4th. They expand in parts other than the muscles of the skin, particularly in the organs of sense and the viscera.(2)

But of all these characters only the first is with difficulty of general application. The fifth pair is an exception to the second, as its semilunar ganglion is formed without the concurrence of any other nerve: we can even to a certain extent mention the olfactory nerve in this respect. The glosso-pharyngeal and the pneumo-gastric with the accessory nerve, also produce a considerable ganglion shortly after leaving the cranium. In fact, these latter unite to give rise to the ganglion: but first, the anomaly resulting from it disappears, when it is considered that these three nerves should be regarded as forming but one: second, almost all the cervical nerves anastomose with each

(1) J. D. Santorini, *Obs. anat.*, cap. iii.—*A.* Bergen, *De nervis quibusdam cranii ad novem paria hactenus non relatis*, Erfort, 1738.—Morgagni, *Ep. anat.*, xvi.—Sœmmerring, *De basi encephali et originibus nervorum e cranio egredientium*, Gottingen, 1778.—Id., *Tabula baseos encephali*, Francfort, 1799.—Stieck, *De quinque prioribus encephali nervis*, Gottingen, 1791.

(2) Huber, *De medulla spinali*, Gottingen, 1741, p. 8, 9.—Asch, *De primo pare medullæ spinalis*, Gottingen, 1750, § xxvii.

other within the dura-mater by intermediate filaments, before that each produces its ganglion. As to the third character, it does not depend on the nerves, but only on the difference in the size and connections of the bones of the skull and the vertebræ. Besides, it is not so exclusive as has been asserted, since we not only sometimes find an opening in the first cervical vertebra for the first cervical nerve, but also the sacral nerves constantly pass through the foramina of a bone originally composed of several pieces immoveably articulated together. In animals we find foramina for the passage of the corresponding cervical nerves, not only in the first cervical vertebra, in all the mammalia except some apes, but also in the second, but even in several of the following in some of these animals, particularly the hog.

The insufficiency of the latter character seems no less evident when we consider, first, that the spinal nerves necessarily cannot go to parts which are not yet formed: second, that the lumbar and sacral nerves are distributed to the genital and urinary organs, and also to the latter portion of the intestinal canal.

It follows then that the distinction between the spinal and the encephalic nerves is not so well marked as we should be tempted to think at first view, and from the assertions of anatomists. Far from it: we shall demonstrate that it is very easy to refer the second to the first, and to show that they are both constructed after the same type.

§ 1851. We have already mentioned the principal differences in authors in respect to the number of the encephalic pairs they establish, and demonstrated that they depend on the different manner of bounding the different portions of the centre of the nervous system. But there are others depending on the fact, that some cerebral nerves have been regarded sometimes as distinct pairs, sometimes only as portions of pairs.

The old anatomists followed the first course, while the moderns, adopting the second, have increased the number of cerebral pairs, which has gradually risen from seven to twelve, and even according to Malacarne,(1) to fifteen.(2)

The twelve cerebral nerves most generally admitted now, are, proceeding from behind forward, 1st, the *sublingual;* 2d, the *accessory;* 3d, the *pneumo-gastric;* 4th, the *glosso-pharyngœal;* 5th, the *facial;* 6th, the *auditory;* 7th, the *external* or *posterior motor;* 8th, the *trifacial:* 9th, the *internal* or *superior motor;* 10th, the *common motor;* 11th, the *optic;* 12th, the *olfactory* nerve.

The reasons for admitting a smaller number of nerves are, first, the olfactory nerve was long considered, till the time of Massa, not as a nerve, but as a portion of the cerebrum: second, till the time of Achillini, the common external motor nerve of the eye was considered as part of the fifth: third, the auditory and the facial nerves have been

(1) *Neuro-encephalotamia*, Pavia, 1791.

(2) Malacarne numbers, properly speaking, seventeen; but the seventeenth is the posterior root of the suboccipital nerve, and the eleventh the sympathetic nerve.

considered as one till the time of Sœmmerring; fourth and fifth, till the time of Andersch, the glosso-pharyngœal and the accessory nerves have been considered only as portions of the pneumo-gastric nerve. Certain anatomists, however, and even before the preceding division was established by Sœmmerring's publication, had considered a greater or less number of the nerves mentioned, as distinct pairs.

Malacarne states the number of the encephalic nerves to be fifteen: first and second, by admitting an accessory nerve to the common motor and to the superior motor nerve; third and fourth, by considering the three branches of the trifacial as so many distinct nerves, which would make sixteen pairs, if instead of distinguishing the glosso-pharyngœal, it had not been united to the pneumo-gastric nerve. But this method is very objectionable, for even when Malacarne had cause to admit his accessory nerves to the motors, he could regard them only as the roots of these latter, to the trunks of which they unite: second, the three branches of the trifacial nerve arise by a common nervous trunk: third, the glosso-pharyngœal nerve deserves to be separated from the adjacent nerves, and considered as a distinct pair more than any which Malacarne insulates.

Farther, we shall have occasion hereafter to show that it would be more convenient to diminish than to increase the number of cerebral nerves, but at present we shall follow the common division.

The principle of the nomenclature of the nerves is not the same in all. Formerly the respective situation of their origin was taken for them, and they were numbered from before backward. Still later this method was preserved, but names drawn from their distribution and their uses were applied. This latter mode is undoubtedly the best, and we follow it much more willingly, because the first does not entirely agree with our mode of considering the nerves, commencing at the spinal marrow.

§ 1852. The cerebral nerves of man differ considerably in respect to volume, form, and origin.

1st. *Volume.* The cerebral nerves generally diminish in size in the following order: the trifacial, the optic, the olfactory, the auditory, the common motor, the pneumo-gastric, the glosso-pharyngœal, the facial, the external motor, the accessory, the hypoglossal, and the superior motor.

Form. Here we may consider,

1st. The *shape.* Most of these nerves are round; the external motor however is slightly flattened, and the olfactory is triangular.

2d. *Texture.* Almost all are fibrous from their origin; in the olfactory nerve alone there are no distinct fibres. In some, the fibres continue separate longer than in others, and they are the more so, the more posterior the origin of the nerves. They generally unite in fasciculi of various sizes before they blend in one trunk. These fasciculi are more numerous, and are more similar in size the more posteriorly the nerves are situated. The two anterior nerves form only one trunk on leaving the cerebrum.

We must mention here the differences in their substance and solidity. The eleven posterior cerebral nerves are composed, like the spinal nerves, of white substance; the olfactory, on the contrary, contains some which is gray. This nerve and the auditory are much softer than the others.

3d. *Origin.* In this respect,

a. The cerebral nerves succeed each other from behind forward.

b. All arise from the inferior part of the cerebrum. Some, particularly the hypoglossal, the accessory, the pneumo-gastric, the glosso-pharyngeal, the posterior motor, the trifacial, the common motor, and the olfactory, come from its lower face. The others arise more or less from its upper face.

c. The origins of some, as the trifacial and the common motor, are deeply concealed in the substance of the parts of the cerebrum from the surface of which they emerge. On the contrary, most of the others cannot be traced beyond the surface.

4th. *Direction* and *progress.* All go forward; but they differ from each other in this respect, that the direction of the posterior ten is forward and outward, while the optic nerve proceeds forward and inward at its posterior part, unites with that of the opposite side, and does not go outward till after this union. The course of the olfactory nerve is obliquely inward and forward.

I. HYPOGLOSSAL NERVE.

§ 1853. The *hypoglossal* nerve, *hyoglossien*, Ch. the *ninth cerebral pair*, the *twelfth* of the usual method (*N. lingualis medius*, Haller; *gustatorius*, Winslow; *lingualis*, Vicq-d'Azyr; *hypoglossus*, Winslow),(1) arises from the anterior face of the medulla oblongata, passes through the anterior condyloid foramen, and is distributed principally to the muscles of the tongue.

It commences by several fasciculi placed after each other from above downward. These fasciculi, arranged in a single series about half an inch long, describe a curved line, which is convex outward, as the superior and inferior are placed a little farther outward than the central. They come from the groove between the pyramid and the olivary body. The inferior arise below this latter eminence; the superior begin a little above the centre of the groove. All are situated a little farther outward than the anterior roots of the first cervical nerve, the lowest of which are about two lines distant from above downward.

The whole series of these fasciculi corresponds with much exactness to the origin of the glosso-pharyngeal, and the pneumogastric nerves, and to that portion of the accessory nerve which arises from the medulla oblongata.

(1) J. F. G. Bœhmer, *De nono pare nervorum cerebri*, Gottingen, 1777.—H. F. Kilian, *Untersuchung über dus neuute Hirnnervenpaar*, Perth, 1822.

They are always very distinctly separated from each other at their origin, and commence by several radicles, which are themselves generally composed of other smaller radicles.

They vary in their number and situation. We admit from four to eight of them. They usually succeed each other uninterruptedly, so that the smallest radicles of the different fasciculi touch each other. Sometimes, however, we observe some which are more remote from the others, and even about a line distant from them, so that this arrangement divides them into two or three bundles of different sizes.

These fasciculi reunite in cords which are generally two and sometimes three in number, each of which passing through a special opening in the dura-mater, proceeds from behind forward, from below upward, and from within outward, towards the posterior orifice of the anterior condyloid foramen. They rarely unite in a single trunk before they enter the dura-mater. Sometimes even an osseous septum divides them for the whole extent of the condyloid canal, into at least two halves, which unite only at the external orifice of this canal.

On leaving the cranium the trunk goes downward, proceeding on the upper part of the condyle, and covered outward in the extent of about an inch, by that of the pneumo-gastric nerve, with which it is generally united by filaments, it passes on the internal carotid artery, and descends from behind forward between the laryngœal branch of the pneumo-gastric and the accessory nerve.

In this place it unites at first near the summit of the transverse process of the first cervical vertebra forward and upward by a considerable filament, with the pneumo-gastric nerve downward and backward, with the first cervical nerve and the great sympathetic nerve by another filament which ascends from the anterior branch of the first, and from the superior cervical ganglion, before which it is situated. It then descends, covered outward by the pneumo-gastric nerve, the posterior belly of the digastricus muscle, the stylo-glossus muscle, and the internal jugular vein, inward by the internal carotid artery, and gives ramifications to the submaxillary gland. When as high as the third cervical vertebra, it passes before the external carotid artery, and forming a large arch, which is convex downward, it goes from behind forward and from below upward, towards the genio-glossus muscle, along the inside of the posterior and inferior hyoid bone.

At the origin of its arch it gives off a considerable and very constant branch, the *descending cervical* nerve (*R. descendens noni*), which goes downward and forward, first along the anterior face of the external carotid artery, where it is intimately united to the trunk of the pneumo-gastric nerve by cellular tissue, then to the inner side of the internal jugular vein, passes above the superior thyroid artery, goes still farther forward on leaving this point, gives off forward and inward a branch which terminates in the anterior belly of the omo-hyoideus muscle, sends others to the muscles of the larynx, and again uniting in the middle of the neck with the descending nerve which comes from the anterior branches of the second and third cervical

nerves, thus forms an arch, the convexity of which is well marked and turned forward.

The convexity of this arch usually gives rise to two branches, which descend along the anterior side of the internal jugular vein. The superior is smaller, and retrogrades to go to the anterior belly of the omo-hyoideus muscle. The inferior is larger, passes under the anterior belly of this muscle, goes downward and forward to the external face of the sterno-thyroideus muscle, distributes several filaments in this muscle and the sterno-hyoideus muscle, and anastomoses in this place by a small but constant filament, with the diaphragmatic nerve. Some ramifications of this branch enter the chest, particularly on the left side, and extend to the upper part of the pericardium.

The trunk of the hypoglossal nerve immediately gives off some branches which go downward into the thyro-hyoideus muscle. Thence it rises again, first below the tendon of the digastricus muscle, then on the external face of the hyoglossus muscle, gives filaments, of which the upper anastomose frequently from its upper and lower parts, but principally from this latter to the muscles of the larynx, then to the hyoglossus, to the genio-hyoideus, and to the genio-glossus muscle, unites with the lingual nerve of the third branch of the trifacial in the upper and anterior part of the hyoglossus muscle, by two or three considerable filaments, and afterwards extends almost to the point of the tongue by ramifications which proceed between the fibres of the hyoglossus muscle.

At the body of the hyoid bone the trunk of the nerve turns on the lingual artery, and enters the genio-glossus muscle, in which it terminates by branches, some of which go to the lower face of the point of the tongue.

We cannot follow the filaments of the hypoglossal nerve into the integuments of the tongue; they stop in the muscles of this organ. From this circumstance we might deduce the very probable conclusion that it serves only to excite the motions of the muscles, and that it is not the proper gustatory nerve, although it communicates by very large anastomoses with the lingual branch of the trifacial nerve, the ramifications of which penetrate distinctly into the integuments of the tongue. Another circumstance gives more weight to this conjecture, viz. the analogy between it and the motory nerves of the other organs of the senses which receive both nerves of sensation and of motion. That these two orders of nerves fulfill different functions, is demonstrated by the observation, that alterations, the primitive or accidental destruction of one of them, is attended only with the loss of one of the two faculties of the tongue, that of the taste when the affection is situated in the lingual branch of the trifacial nerve, and that of motility when the hypoglossal nerve is affected.(1) The loss of taste in one

(1) The sense of taste is lost in trisma, but the levator muscles of the lower jaw receive their nerves from the fifth pair and not from the hypoglossal nerve (Haller, *El. phys.*, vol. v. p. 112). The congenital absence of taste has been observed in a patient where the lingual branch went to the occiput and not to the tongue (Colombo, *De re anat.*, Paris, 1762, p. 486.)

case where the hypoglossal nerve was injured(1) even when this lesion would not have been admitted as probable, would not prove that the two nerves concurred in the function of taste, for on one side the lesion might produce this effect only from the connections between the two nerves; and secondly a case cited by Heuermann would farther prove that it cannot be admitted, since on account of the distribution of the hypoglossal nerve and of the lingual branch of the trifacial nerve, the hypoglossal nerve could not alone be the nerve of taste, as should be concluded from this fact, considered as a peremptory argument in favor of the power attributed by the author to the nervous trunk supposed to be injured.

But the difference of function between the two nerves is not proved by the cases where the loss of the motion of the tongue without that of taste, or the loss of taste without that of the motion of the tongue(2) in general, have been observed, since the same phenomenon is seen in other parts which receive only one nerve, and which cannot consequently be explained in the same manner.

II. ACCESSORY NERVE.

§ 1854. The *accessory* nerve,(3) *trachelo dorsal*, Ch. (*N. spinalis ad par vagum accessorius, accessorius Willisii*),(4) arises by numerous filaments from the posterior part of the lateral face of the posterior cord of the spinal marrow, ascends between the posterior roots of the upper six cervical nerves and the ligamentum denticulatum, nearer the former than the latter, consequently also nearer the posterior than the anterior roots of the cervical nerves, penetrates into the skull through the occipital foramen behind the vertebral artery, receives some filaments from the latter parts of the medulla oblongata, is situated below near the pneumo-gastric nerve, with which it emerges from the skull through the posterior foramen lacerum, and is distributed partly in the upper region of the pharynx, partly also in some muscles of the back.

Its lowest and smallest root usually arises at the height of the superior filament of the posterior roots of the seventh cervical pair; the second at that of the upper part of the posterior root of the fifth; the third and fourth at that of the upper part of the fourth; the fifth opposite that of the third; the sixth between the second and third; and the seventh opposite the posterior root of the second. Many of these roots

(1) Heuermann, *Physiologie*, vol. ii. p. 295.
(2) Sœmmerring, *Nervenlehre*, p. 262.—Scarpa, *Tab. neurol.*, Pavia, 1794, p. 16-17. Two cases.
(3) Often termed the *accessory nerve of Willis*, but wrongly, as it had previously been figured by Eustachius and described by Cotter.
(4) J. F. Lobstein, *De nervo spinali ad par vagum accessorio*, Strasburg, 1760.—A. Scarpa, *Uber den zum achten Paare der Gehirnnerven hinlaufenden Beinerven des Rückenmarnes;* in the *Abhandl. der Josephsakad*, vol. i. p. 385.—Its origin has been described perfectly by Huber, *De medullâ spinali, speciatim de nervis ab eâ provenientibus*, Gottingen, 1741, § vii-xi.

sometimes communicate in one or several points with the anastomotic filaments of the middle and superior cervical pairs.

Usually no root of the accessory nerve arises from a higher point of the spinal marrow.

Sometimes, however, the whole posterior root of the first cervical nerve joins it and forms with it a small ganglion. But this ganglion is not constant when the nerves unite, and we should even think it extremely rare, since it has never been observed by Haller, Ash, Lobstein, and Scarpa, who have remarked only a slight thickening of the nerve.(1) We have never seen it but a few times, notwithstanding our numerous researches.

Three or four roots generally arise within the skull from the lateral face of the posterior cord of the medulla oblongata ; these are behind the roots of the hypoglossal nerve.

These ten or eleven roots gradually become longer and thicker from below upward, and go towards the trunk of the nerve at angles which are more acute the lower their origins. The lowest is in great part concealed in the pia-mater, through which it only penetrates. The spinal roots also are usually single, while those arising from the medulla oblongata are generally composed of two short radicles united at an acute angle, each of which is formed by three or four filaments. These radicles, one of which is superior, the other inferior, and the second of which ascends in a more perpendicular direction, soon reunite. In considering the whole series of roots, we recognize that they gradually become more anterior from below upward.

The nerve enlarges as it ascends, goes imperceptibly outward, and is attached above by short filaments to the trunk of the pneumo-gastric nerve.

The accessory nerve never arises lower than the point indicated. On the contrary it often commences higher, opposite the sixth cervical vertebra, sometimes even but more rarely opposite the fifth. In some subjects it receives from the spinal marrow only two or three roots, which are then proportionally thicker.

The number of the filaments from the medulla oblongata is sometimes less than we have mentioned: it is rarely and perhaps never greater. Sometimes they resemble by being single those which arise from the spinal marrow.

So likewise the accessory nerve does not always arise exactly in the same place.

It is very rarely united by a filament with the posterior root of the second cervical nerve.(2)

It does not anastomose with the hypoglossal nerve within the skull.(3)

(1) Scarpa, *loc. cit.*, p. 396.

(2) Scarpa, *loc. cit.*, p. 395. This anatomist has observed this union only twice in his numerous dissections. We have found it only once.

(3) Scarpa, *loc. cit.*, p. 397, does not admit this assertion of Winslow. We have never seen the anastomosis mentioned by this latter.

It generally passes through the dura-mater in connection with the pneumo-gastric nerve: but sometimes also it emerges through a special opening behind the latter, with which however it reunites.

All these differences are observed not only in different persons, but frequently in the same person on different sides of the body.

In passing through the dura-mater the accessory nerve is inclosed in a sheath with the pneumo-gastric nerve; but before emerging through the posterior foramen lacerum it divides into an internal and an external branch.

The *internal* branch gives off first two branches which unite with each other and with a third which descends from the pneumo-gastric nerve, and produces the *superior pharyngœal nerve.* It then receives some filaments from the pneumo-gastric nerve, sometimes communicates with the hypoglossal nerve, then reunites with the trunk of the pneumo-gastric nerve to form a ganglion.

The *external* branch proceeds for about two inches descending deeply behind the internal jugular vein, at first between this vessel and the occipital artery, then between it and the sterno-cleido-mastoideus muscle. It turns a little on this muscle and goes forward, sometimes passes through it, gives to it filaments which anastomose with those of the third cervical nerve, then continues to descend but from before backward, passing on the internal jugular vein, enlarges considerably by uniting with two anastomosing branches, the upper of which arises from the anterior branch of the second cervical nerve and the lower from that of the third, passes on the levator anguli scapulæ muscle, anastomoses with the ramifications of the fourth and fifth cervical nerves, and comes to the internal face of the trapezius, in which it is distributed. No other muscles receive filaments from it.

III. PNEUMO-GASTRIC NERVE.

§ 1855. The *pneumo-gastric*, the *par vagum*, the *middle sympathetic*, the *pulmonary*, the *vocal* nerve, the *eighth*, or according to the new calculation, the *tenth* pair (*N. pneumogastricus*, Chaussier; *N. vagus*, *N. sympathicus medius*, Winslow; *N. pulmonalis*, Bartels;(1) *par octavum*, Willis;(2) *decimum*, Andersch),(3) arises from the side of the posterior prolongation of the cerebellum between the accessory and the glosso-pharyngœal nerves, emerges from the skull through the posterior foramen lacerum, and descending is distributed

(1) *Respiration*, p. 210.

(2) This term, however, includes the following or the glosso-pharyngeal nerve.

(3) Neubauer, *Descript. nerv. cardiac.*—Andersch, in the *Nov. comm. Gott.* vol. ii. published in Haase, *Cerebri nervorumque anat.*, Leipsic, 1781, and in Ludwig, *Script. neurol. min.* vol. ii.—Walter, *De nerv. abdom.*, Berlin, 1800.—Wrisberg, *De ganglio plexuque semilunari*, &c. sect. ii., *De pari octavo;* in the same *Comment.* vol. i. 1800.—Scarpa, *Tab. neurolog.*, Pavia, 1794.

in the upper part of the alimentary canal, the stomach; second in the organs of respiration; hence the term *pneumo-gastric.*

§ 1856. It arises by from ten to sixteen filaments from the lower part of the lateral face of the posterior prolongations of the cerebellum. The inferior are situated far behind the anterior, and form a series which is generally single and five or six lines long. Sometimes, however, several are more anterior than the others;(1) this is particularly the case with those at the top of the series, although there is no disposition indicating any tendency to produce distinct roots. On the contrary, in this formation the pneumo-gastric nerve is similar to the formation of the anterior cerebral nerves, as its origin is thus more rounded, which form is remarkable in several of the mammalia, particularly the ruminantia. These filaments arise principally towards the anterior and inferior edge of the posterior prolongation of the cerebellum, in the groove between this prolongation and the olivary body. They do not extend so high as this latter, and terminate below long before those of the hypoglossal nerve. Some of them frequently anastomose with the transverse medullary striæ on the floor of the *calamus scriptorius*, and hence these striæ seem to concur in their formation.(3) Others, particularly some of the inferior, come from the lower extremity of the olivary body.(4)

These filaments are generally single, and not cleft at their internal part. They are sometimes separated and sometimes united from their origin in three or four fasciculi. The inferior are commonly very intimately connected with the accessory nerve. The superior most generally communicate by a transverse filament with the glosso-pharyngœal nerve even within the skull.

These filaments and fasciculi unite in a flattened trunk about one line and a half broad, one quarter or one fifth of a line thick, and always larger at its upper part where they are interlaced with each other. This trunk goes outward and backward. It is inclosed in a small canal of the dura-mater, through which it comes from the cranium, through the anterior part of the foramen lacerum, before the origin of the internal jugular vein. It is separated from this vein by a prominence of bone which comes from the petrous portion of the temporal bone or from the occipital bone, or from both, and from the accessory and the glosso-pharyngœal nerves by the dura-mater.

The fasciculi hitherto distinct do not entirely unite in a rounded cord except within this canal. The rounded cord on leaving the foramen lacerum is united very intimately by mucous tissue with the

(1) Coopmans, *Neurol.*, p. 118.—Sœmmerring, p. 102.
(2) Santorini, *Septemdecim tabulæ*, p. 27.—Girardi, *ibid.*—Vicq-d'Azyr, in the *Mém. de Paris*, 1784, p. 594.
(3) Desmoulins, *Sur le rapport qui unit le developpement du nerf pneumo-gastrique à celui des parois du quatrième ventricule;* in the *Journ. de phys. expérimentale*, vol. iii., p. 362.
(4) Vicq-d'Azyr, *loc. cit.*, p. 594.

glosso-pharyngœal nerve, the hypoglossal and the ascending branch of the superior cervical ganglion. It is situated at first behind the glosso-pharyngœal and before the hypoglossal nerve, but it soon passes behind this latter, is separated from the glosso-pharyngœal nerve by the internal jugular vein, leaves the hypoglossal nerve on the transverse process of the first cervical vertebra, and descends outward and a little backward before the primitive carotid artery, between it and the internal jugular vein, intimately united to these two vessels by a mucous tissue destitute of fat and more loosely connected to the intermediate filaments of the sympathetic nerve which are situated behind it and placed in the rectus capitis major anticus and the longus colli muscles.(1)

In passing through the foramen lacerum the pneumo-gastric nerve anastomoses by some filaments with the accessory nerve, and shortly after leaving this opening it communicates also with the glosso-pharyngœal nerve and the superior cervical ganglion. It then gives off a branch which unites with two filaments from the inner branch of the accessory nerve, and gives rise to the *pharyngœal* or *superior pharyngœal* nerve (*N. pharyngœus*, s. *pharyngœus superior*, s. *primus*.)

This nerve goes obliquely from above downward and from without inward on the inside of the internal carotid artery, sends an anastomosing filament to the glosso-pharyngœal nerve, bulges a little, and forms at the height of the middle constrictor of the pharynx a considerable plexus termed the *pharyngœal* (*plexus pharyngœus*). This plexus receives filaments from the laryngœal, the glosso-pharyngœal nerves, and from the superior cervical ganglion ; its filaments are distributed principally in the middle constrictor, but some go to the upper constrictor of the pharynx: a few descend along the primitive carotid artery, where they anastomose with the ramifications of the glosso-pharyngœal and the superficial cardiac nerves.

The *inferior pharyngœal* nerve (*N. pharyngœus inferior*, s. *minor*), which also is not constant, arises directly below the superior pharyngœal nerve. This nerve soon anastomoses with the preceding, and also with one or several of the anterior filaments of the superior cervical ganglion, sends filaments to the pharyngœal plexus, and is distributed in the middle constrictor of the pharynx.

At the place where the pharyngœal nerves are given off and sometimes also a little higher, the trunk of the pneumo-gastric nerve becomes much thicker and its texture is closer for about an inch: its fasciculi separate very much, and a reddish gelatinous substance is deposited between them. A real ganglionnary plexus then forms. The remnant of the internal branch of the accessory nerve after sending an anastomotic twig to the pharyngœal nerve enters this plexus at about its centre, sometimes in one branch, sometimes also in several filaments which ramify and interlace differently, so that this branch forms the

(1) J. H. Haase, *De nervo phrenico dextri lateris duplici parisque vagi per collum decursu*, Leipsic, 1790.

lower part of the plexus, and seems also to belong to the pneumo-gastric nerve.

The trunk of the pneumo-gastric nerve is in fact directly attached to this ganglion from before backward; but it is sometimes, although rarely, connected with it only by some filaments of communication.

A more distinct development of this plexiform dilatation of the nerve occurs when it divides into two portions which unite only at the lower part of the neck; but such an arrangement is extremely rare: it has been observed only once in five hundred cases, and this was on the right side.(1)

The *superior laryngœal* nerve (*N. laryngœus superior*), which is commonly larger than the inferior, usually arises from the upper part of this ganglion.

This nerve descends between the internal carotid artery and the superior cervical ganglion, most generally anastomoses by one or several filaments with this latter, the pharyngœal plexus, and the hypoglossal nerve, and divides into an external and an internal branch.

The *external* goes inward, and sends filaments to the inferior constrictor muscle of the pharynx, the crico-thyroideus, the sterno-thyroideus, and the hyo-thyroideus muscles, to the thyroid gland, and to the membrane of the pharynx; these filaments enter the cavity of the larynx between the cricoid and thyroid cartilages.

The *internal* branch passes through the hyo-thyroid membrane between the hyoid bone and the thyroid cartilage. It distributes soft and thick filaments in the membrane and glands of the epiglottis, the mucous membranes of the pharynx and larynx, several small muscles of the larynx, particularly the arytenoideus and the crico-thyroideus, and anastomoses with the filaments of the inferior and recurrent laryngœal nerve.

After the superior laryngœal nerve, we see arise either from the ganglionnary plexus or directly below it some filaments which are not constant; these unite to the descending branch of the hypoglossal nerve, and also to the first cervical nerve, and to the soft nerves which go to the internal carotid artery.

After giving off these branches, the trunk of the pneumo-gastric nerve becomes more compact, and descends in the manner mentioned above, but gives off no ramifications. It then represents a cord composed of less distinct fasciculi and which is generally uneven by a kind of indentation, but its surface is surrounded here and there by very minute filaments which interlace like a plexus.(2) It gives off about an inch or an inch and a half above the origin of the primitive carotid artery (but an inch higher on the right than on the left side), and at about the centre of the neck, on both sides, the *cardiac* nerves (*R. cardiaci*). These descend from within outward and from behind for-

(1) Wrisberg, *De nervis pharyngis;* in Ludwig, *loc. cit.*, vol. iii., p. 57.
(2) Prochaska, *De struc. nerv.*, tab. ii., fig. 7, 7, ee.—Reil, *De struct. nerv.*, tab. i., fig. 2, 3, 4.

ward in the carotid artery and the innominata trunk, anastomose with the superficial cardiac nerves, and are distributed to the arch of the aorta. We generally find three or four on the right side, the upper of which is the largest and most constant. There are one or two on the left side.

The trunk of the pneumo-gastric nerve goes forward, is situated behind the innominata vein, passing on the right before the subclavian artery, on the left before the arch of the aorta, thus comes into the chest, enlarges considerably, and divides into two halves, of which the lower and larger is the continuation of the trunk, and the upper is smaller, and is termed the *inferior laryngœal ascending* or *recurrent* nerve, *tracheal*, Ch. (*N. recurrens*, s. *adscendens*, s. *laryngeus inferior*).

The two recurrent nerves arise within the chest, the left much lower than that of the right side. They ascend first from before backward, then vertically, send some filaments to the cardiac nerves which come from the pneumo-gastric, the middle and inferior cardiac nerves which come from the ganglionnary nerves, form with them a plexus, then turn from before backward, the right on the right subclavian artery, the left on the extremity of the arch of the aorta, and are placed behind the primitive carotid and inferior thyroid artery, between the trachea and the esophagus, and rise to the larynx. In this course they give off first the branches called the *superior tracheal* nerves (*R. tracheales superiores*), which descend before the trachea and anastomose with the preceding, arrive at the bronchia and the pulmonary plexus of their side, are distributed in the membrane of the trachea, the pharynx, and the thyroid gland, and communicate with some filaments of the cervical portion of the sympathetic nerve.

Finally, when as high as the larynx the recurrent nerve is distributed in the inferior constrictor of the pharynx and the cricoarytenoid muscles, enters the cavity of the larynx between the cricoid and thyroid cartilages, and terminates in the thyroid cartilage, the arytenoid muscle, and the mucous membrane of the larynx, by anastomosing by several branches with the superior laryngœal nerve.

The recurrent nerve is sometimes double, but this is rare, and when it occurs it is always on the right side, if we judge from observations made hitherto. The unusual nerve is smaller than the other, and arises from the trunk some lines below it, turns like it on the subclavian artery, ascends between the esophagus and the trachea, anastomoses by a large twig with the normal recurrent nerve, and is distributed with the latter.(1)

This anomaly seems to indicate an effort to establish a perfect similarity between the right and left sides, since the recurrent nerve always arises lower than that of the right side.

It is very probable that the recurrent nerve results from the plexiform division of the trunk of the pneumo-gastric, and that its existence

(1) Wrisberg, *De nervis abdominis*, Gottingen, 1780.

is connected with the primitive shortness of the neck, since the larynx is much nearer its origin in the early periods of life than subsequently. This hypothesis would explain its arrangement in the same manner as the high origin and long course of the spermatic vessels. Farther, it is impossible to deny the analogy between the distribution of the nerves and vessels in this region of the body, since the superior and inferior laryngœal nerves and the superior and inferior thyroid arteries manifestly correspond.

§ 1857. The trunk of the pneumo-gastric nerve having given off the recurrent nerve, goes backward on the posterior face of the trachea.

There it supplies first five or six *inferior tracheal* nerves (*V. tracheales inferiores*), some of which proceed before, others behind the trachea. The former anastomose with the filaments of the superior tracheal nerves and with others coming from the inferior cervical ganglion. Some descend before on the ramifications of the bronchiæ and of the pulmonary artery. Others enter the muscular and mucous tunics of the trachea, bronchia, and esophagus, and terminate in the *pulmonary plexus* (*plexus pulmonalis*).

This plexus commences directly above the bronchia of each side. It is formed principally by the fasciculi of the trunk of the pneumo-gastric nerve, between which there is a very vascular mucous tissue. It extends behind the bronchiæ into the substance of the lungs, surrounding the finest ramifications of the bronchial tree, to the muscular tunic, and even to the mucous membrane to which it sends filaments. Beside the trunk of the pneumo-gastric nerve which develops itself to give rise to it, it also receives some filaments which are less numerous, from the superior thoracic and from the inferior cervical ganglion of the great sympathetic nerve.

Five or six fasciculi on the right side and only two or three on the left, arise from the lower part of each of these two pulmonary plexuses. These fasciculi are first situated very far from each other, but frequently anastomose by intermediate filaments. After passing some lines they unite on each side in a cord, which is the continuation of the trunk of the pneumo-gastric nerve, and the right of which is larger than the left. These cords descend, that of the left before, that of the right behind, and at the side of the esophagus.

In their course they frequently anastomose principally by anterior filaments which descend from the right cord, send filaments to the esophagus, and others which are smaller to the aorta, and enter the abdomen with the esophagus, passing through the esopahgœan fissure of the diaphragm.

The pneumo-gastric nerve terminates in the stomach. That of the right side which is the largest, goes to the right portion and the posterior face of the viscus; that of the left side is distributed in its left part and on its anterior face.

The *right* forms around the cardiac orifice a large plexus, from which numerous filaments arise, some of which are distributed to the posterior face of the stomach; others situated behind the coronary

artery of the stomach, proceed along its small curve to the pylorus, and there anastomose with those of the left nerve and with the superior gastric plexus of the great sympathetic nerve: finally, some which do not belong to the stomach pass behind it, arrive at the right portion of the solar plexus and also the plexuses which come from this latter on the right side, and are distributed to the hepatic artery and its branches, to the vena-portæ, the duodenum, and the pancreas.

The *left* divides at the cardiac orifice into several branches which separate in rays, communicate less frequently, follow the small curve of the stomach from left to right, send ramifications to the anterior face of this viscus, anastomose near the pylorus with the filaments of the right pneumo-gastric nerve, and leaving the stomach, terminate anteriorly before the pylorus, in the hepatic plexus formed by the ganglionary nerve.

IV. GLOSSO-PHARYNGŒAL NERVE.

§ 1858. The *glosso-pharyngœal* nerve (*N. glosso-pharyngœus*, Haller; s. *lingualis pneumogastrici*, Vicq-d'Azyr; s. *octavus*, Andersch), has been considered until lately as the anterior part of the pneumo-gastric nerve. In fact, if we regard its origin, the communications between it and this nerve, both within the skull and at its passage through the posterior foramen lacerum, finally the manner in which it is distributed, we discover that it really forms a part of the pneumo-gastric nerve, but it is so largely developed that it may be considered a proper and distinct nerve. It arises by five or six filaments, which may be easily separated from each other, and the anterior of which are generally smaller than the posterior. It arises between the pneumo-gastric and facial nerves, some distance behind the latter, but directly before the upper filaments of the first, from which its own cannot be separated. It comes from the upper part of the lower face of the inferior prolongation of the cerebellum, from the depression between this cord, the olivary bodies, and the posterior edge of the annular protuberance, directly behind the latter, from which several of its filaments sometimes emanate. It goes outward and at first a little forward, covered by the fourth lobe of the cerebellum, usually anastomoses within the skull by a large branch with the pneumo-gastric nerve,(1) and after proceeding five or six lines, passes through the arachnoid membrane. It is round and about a half or three quarters of a line thick, and emerges from the skull through the anterior part of the posterior foramen lacerum, directly before the pneumo-gastric nerve, but inclosed in a special canal of the dura-mater. About four or six lines from its entrance into this canal, it becomes a small, oblong, rounded, and generally very distinct ganglion about five lines long, which extends into the canal of the dura-mater and the anterior part of the foramen lacerum.

(1) Andersch, *Fragm. descript. nerv. cardiac.*, in Ludwig, *loc. cit.*, vol. ii. p. 115.

This ganglion gives off, above, a filament, which enters into the cavity of the tympanum, and then divides into two branches; one ascends along the promontory, gives off a small filament to the membrane of the foramen rotundum, and passes through the petrous portion of the temporal bone to the superficial temporal nerve, and the other passes below the osseous portion of the Eustachian tube, and goes to the carotid canal, where it anastomoses with the great sympathetic nerve.(1)

The ganglion also gives off other filaments, which pass through the canal of the dura-mater to go to the trunk of the pneumo-gastric, to the accessory, and the great sympathetic nerves.

After emerging from the posterior foramen lacerum, the glosso-pharyngeal nerve is separated from the pneumo-gastric trunk by the internal jugular vein, before which it is situated. Thence it goes downward and forward, passing on the internal carotid artery, descends situated at first closely on the outside, then on the anterior part of this artery, between it, the external carotid artery, and the stylo-pharyngœus muscle, passes between this muscle and the glosso-pharyngœus muscle, then between this latter and the hyoglossus, and thus comes to the lower and posterior part of the tongue.

On leaving the skull it sends a filament of anastomosis to the stylo-hyoid branch or to the digastric branch of the facial nerve and another to the trunk of the pneumo-gastric nerve. It then gives off one or two which descend along the internal and the primitive carotid arteries, anastomose first with the pharyngœal branch of the pneumo-gastric nerve, and then going to the lower part of the neck communicate with some filaments of the sympathetic nerve particularly with the superficial or even the middle cardiac nerves. Still farther on, it sends off three or four filaments to the stylo-pharyngeus muscle, and also to the middle and superior constrictors of the pharynx and to the amygdalæ, and some which enter the pharyngœal plexus of the pneumo-gastric and the ganglionnary nerve.

The glosso-pharyngœal nerve then passes between the styloglossus and hyoglossus muscles; then situated in the tongue below the lingual nerve of the fifth pair and above the hypoglossal nerve, both larger than it and with which it does not communicate at least by very evident filaments, it is distributed partly in the muscles of the tongue, the membrane of the soft palate and the amygdalæ by several ramifications which interlace like a plexus; partly in the integuments of the base of the tongue, its large papillæ, and the mucous membrane of the epiglottis by other filaments which are situated lower and nearer the median line than the preceding, and pass from below upward through the substance of the tongue.

(1) Rosenmuller, *Handbuch der Anatomie*, 1816. p. 407.—Jacobson, in the *Acta reg. societ. Hafniensis medicæ*, vol. v. Copenhagen, 1818. p. 292.—This anastomosis has been doubted by Kilian, but is admitted by Lobstein.

V. AUDITORY NERVE.

§ 1859. The *auditory* or *acoustic* nerve, *labyrinthique*, Ch., the *soft portion of the seventh pair* (*N. auditorius*, s. *acusticus*, s. *portio mollis nervi acustici*),(1) is very soft, but harder than the olfactory and the portion of the optic nerve behind the decussation; it generally communicates so evidently with all the white striæ of the floor of the *calamus scriptorius*, or at least with several of them, that it may be said to arise partially from it.

Its upper and external part is formed by these striæ. The fibres connected with it follow one another from before backward and are separated by unequal and inconstant spaces; they turn on the inferior prolongations of the cerebellum, on the surfaee of whieh they are intimately connected. Their direction is forward and downward, the anterior proceeding transversely, the posterior obliquely from below upward.

The inner part of the nerve is larger than the external portion, but they are not separated; it arises below and farther forward than it from the lateral face of the spinal prolongation of the cerebellum, directly before and above the glosso-pharyngœal nerve and the upper part of the pneumo-gastric nerve.

The trunk of the nerve then goes forward, outward and downward on the posterior edge of the transverse prolongation of the cerebellum, and is united to its upper face so intimately for about three lines, that it may properly be considered as arising from this part of the eneephalon. It is slightly covered outward by the fourth lobe of the cerebellum, being often attached in this place to its medullary substance, so that we may admit also that it partially arises there, which is worthy of note but not astonishing, on account of the analogy resulting from it with what is seen in the other two nerves, the optic and olfactory, which are only nerves of sense.

Its internal face is grooved lengthwise, and receives the facial nerve. It is soft at its origin, and we do not pereeive there distinct fibres, but on leaving the encephalon it evidently becomes fibrous and still more solid.

On leaving its origin the auditory nerve goes obliquely forward, outward, and upward, and soon penetrates the internal auditory foramen, which is much larger than it. It then divides into two branches, which continue united externally to its base; the *anterior* enters the cochlea and the *posterior*, the vestibule and the semicircular canals. We shall describe these branches when speaking of the ear.

(1) J. F. Meckel, *Obs. anat. sur la glande pineale, sur la cloison transparente et sur l'origine de la septième paire*, in the *Mém. de Berlin*, 1765. p. 91–100.—A. Scarpa, *De nervo auditorio*, in his *Anat. disquis. de auditu et olfactu*, Pavia, 1789, sect. ii. cap. iii.

VI. FACIAL NERVE.

§ 1860. The *facial* or small *sympathetic* nerve, the *hard portion of the seventh* nerve, the *seventh pair*, the *seventh cerebral* nerve (*N. facialis*, s. *sympathicus minor*, s. *communis facili*, s. *portio dura septimi*, s. *nervus primus septimi paris*, s. *par septimum*)(1) is much smaller than the auditory nerve; it arises by two roots which are generally distinct, although placed one against the other. One is external and posterior, the other much larger is internal and anterior. It arises within, below, and before the auditory nerve, which receives it in a groove situated along its internal face, directly at the side of this nerve and before the glosso-pharyngæal nerve. It arises from the posterior edge of the annular protuberance, from the uppermost part of the lower face of the rachidian prolongation of the cerebellum; sometimes, also, according to Malacarne, by several filaments from the floor of the fourth ventricle, that is, from the most anterior transverse medullary striæ. The filaments from the annular protuberance, particularly the internal, seem to come only from this tubercle; but examining them attentively, we see that they are separated from the principal root only by the posterior fibres of the protuberance existing between this latter and them.(2) Very possibly, however, from this reason they are in fact separated from the principal root, and first arise from the pons Varolii. The external root of the nerve, which is much smaller than the internal, is always formed of three or four filaments which unite anteriorly in one or two fasciculi. It is situated between the internal root and the auditory nerve, and some of its filaments frequently seem, at least in situation, to belong to the auditory nerve rather than to it.

The nerve leaves the annular protuberance at about the centre of the space between the anterior and posterior edges of this latter, goes forward and outward to arrive at the internal auditory passage, through which it proceeds above and before the auditory nerve to the canal of Fallopius, which it exactly fills, and passes entirely through it. Its direction is consequently first outward and backward, then downward behind and above the cavity of the tympanum, and it emerges through the stylo-mastoid foramen, to be distributed in a considerable portion of the skin and of the muscles of the head.

In its course along the canal of Fallopius, it gives off first downward and forward, a filament which reunites with the superior branch of the recurrent nerve given off by the second branch of the fifth pair, to form the *superficial petrous* nerve (*N. petrosus superficialis*).

(1) J. H. Meckel, *De quinto pare nervorum cerebri*, Gottingen, 1748, for the portion of the facial nerve contained in the Fallopian canal.—J. F. Meckel, *Dissertation anatomique sur les nerfs de la face*, in the *Mém. de Berlin*, vol. vii. 1752.—See also Bock, *Beschreibung des fünften Nervenpaares*, Leipsic, 1817. tab. i. ii.
(2) Gall, *loc. cit.*, p. 206.

It then gives off a little downward and outward, behind the cavity of the tympanum, one or several filaments for the muscles of the little bones of the ear.

A little lower, some distance above the stylo-mastoid foramen, it sends off a considerable branch, the *cord of the tympanum* (*chorda tympani*), which descends at first along the trunk, then goes outward and upward, passes through the posterior wall of the cavity of the tympanum, enters this cavity at the side of the pyramid, descends from behind forward between the malleus and incus situated on the former bone; it anastomoses by one or more filaments with the tympanitic nerves of the fifth pair, but gives no ramification to the membrane of the tympanum, leaves the tympanum through the fissure of Glaser, descends on the inside of the ascending branch of the jaw, and gradually becoming thicker, anastomoses at an acute angle with a twig of the lingual branch of the trifacial nerve which meets it.

It does not seem to us probable, from our dissections, that the superficial petrous nerve and the cord of the tympanum, are only a filament of the fifth pair, which is fitted to the facial nerve, and which does not really anastomose with it,(1) although we consider the lower and prominent portion of the cord of the tympanum, as belonging to the branch of the trifacial nerve.

After leaving the stylo-mastoid foramen, the facial nerve gives off the following branches:

1st. One single or double branch, termed the *posterior*, *inferior*, or *deep auricular* nerve (*N. auricularis posterior*, *profundus inferior*), which sends one or more inconstant filaments into the mastoid process, then goes upward and backward and divides into two branches, an anterior and a posterior, the former of which is the larger.

The posterior, which sometimes forms the first branch of the facial nerve, ascends on the mastoid process, is distributed in the skin which covers it, extends to the occipitalis muscle, to which it distributes filaments, and anastomoses with the ramifications of the small occipital nerve.

The anterior arrives at the lower and posterior part of the cartilaginous portion of the auditory foramen, and of the external ear, sends some filaments to the skin of this region, and also to the posterior auricular muscle, and passing through the cartilage, is distributed in the integuments of the auditory passage.

2d. The *stylo-hyoid* nerve (*N. stylo-hyoidcus*) which is distributed partly in the upper portion of the muscles attached to the styloid process, and the posterior part of the digastricus muscle of the jaw, and partly sends several anastomosing filaments to the upper part of the ganglionnary nerve, and to the middle cutaneous nerve, given off by the third cervical nerve.

3d. A branch termed the *digastric* (*R. digastricus*), which passes through the posterior belly of the digastricus muscle, and anastomoses

(1) Cloquet, *Tr. d'anat.*, vol. ii. p. 610.

with the ramifications of the glosso-pharyngœal, the pneumo-gastric, and the accessory nerves.

4th. Sometimes a filament which anastomoses with the posterior twig of the inferior auricular nerve, and with the filaments of the anterior branch of the third and fourth cervical nerves. This filament exists particularly when the inferior auricular nerve is small.

After giving off these ramifications, the trunk of the facial nerve, passing under the ear, enters the parotid gland from above downward and from behind forward, assumes in this gland a direction which is oblique from below upward, still continuing to go forward, and forms within it a considerable plexus, the *parotid plexus* (*plexus parotideus*). This plexus i formed by the nerve dividing at the posterior edge of the ascending branch of the jaw, into from two to five branches, which may always be referred to two which vary in direction and distribution. Of these branches, one is superior, the other inferior, and smaller than the former. They anastomose frequently together, and thus form a polygon convex forward, upward and downward, whence arise the other ramifications of the nerve, which are distributed in the skin of the upper, middle, and lower portions of the face, in that of the upper part of the neck and in most of the muscles of the face.

Several considerable branches constantly unite posteriorly with this plexus ; they come from the superficial temporal nerves which arise from the third branch of the trifacial nerve, and which turn from behind forward on the posterior edge of the ascending branch of the jaw.

By examining this plexus from above downward and from behind forward, we observe that it gives off some ascending, some anterior, and some descending branches, which frequently anastomose together by intermediate twigs, equally distant from the edge of the parotid gland.

I. ASCENDING BRANCHES.

§ 1861. The ascending branches are the *temporal* and the *malar* nerves (*N. temporales et malares*). Chaussier terms them collectively the *temporo facial branch.*

a. Temporal nerves.

§ 1862. We find,

5th, 6th, 7th. Two or three *temporal* nerves, which give some small filaments to the parotid gland, ascend on the malar bone, anastomose between them with the superficial and deep temporal branches of the submaxillary nerve posteriorly, and with the frontal and lacrymal twigs of the first branch of the trifacial nerve, are distributed on the temporalis muscle, and send ramifications to the skin of the temples, to that of the anterior part of the external ear, the anterior auricular muscle,

and the external and upper part of the orbicularis palpebrarum muscle.

When only two temporal nerves exist, the anterior is larger than the other.

b. Malar nerves.

§ 1863. 8th and 9th. These are usually two nerves; they proceed more forward and upward than the preceding, and passing on the malar bone, they are distributed in the skin which covers this bone and the external edge of the orbit, in the outer part of the eyelids, in the external and lower part of the orbicularis palpebrarum muscle, finally in the posterior part of the zygomatici muscles.

II. ANTERIOR BRANCHES OR BUCCAL NERVES.

§ 1864. There are usually three, more rarely two, anterior branches or *buccal* nerves (*N. buccales*).

The central one is the largest.

They go almost directly forward on the upper and middle portion of the masseter muscle, beyond its anterior edge. The middle is situated directly on the excretory canal of the parotid gland.

The superior, passing under the zygomatici muscles, to which it gives filaments, ascends towards the lower eyelid, and goes to the inner angle of the eye, where it often anastomoses with the infra-trochlear nerve given off by the fifth pair.

The central divides into ascending and anterior twigs.

The ascending twigs arrive at the lower part of the orbicularis palpebrarum muscle, the muscles of the sides of the nose, and the skin which covers them, anastomose with some filaments of the infraorbitar nerve which come from the fifth pair, particularly with the external, and terminate in the levator muscles of the upper lip, the orbicularis oris, and the skin of the upper lip.

The inferior go directly forward, are distributed in the buccinator muscle, the skin of this region and that of the lower lip. They anastomose with the buccal nerve which comes from the third branch of the fifth pair.

III. DESCENDING BRANCHES.

§ 1865. The descending branches, *cervico-faciales*, Ch., arise from the lower and smaller trunk, which commonly anastomoses at its origin by some filaments with the superior.

This trunk generally divides into two branches.

The superior goes forward on the lower part of the masseter muscle. anastomoses with the inferior buccal nerve, and is distributed in the skin of the lower lip, the depressor labii inferioris, and the buccinator muscle.

The inferior descends towards the lower angle of the jaw, and divides near the angle of this bone, into a superior and an inferior twig.

The superior twig, the *marginal* nerve (*N. marginalis*), proceeds above and along the edge of the lower jaw, goes forward and upward, distributes its filaments in the muscles which depress the lower lip and in the skin of the chin, and anastomoses with the inferior labial nerves of the third branch of the trifacial nerve.

The inferior divides in turn into two or three ramuscules, the *superior cutaneous cervical* or *submaxillary* nerves (*N. subcutanei colli superiores*), which descend under the jaw, are distributed in the upper part of the skin of the neck and in the platysma myoides muscle, and anastomose frequently with the ascending twigs of the anterior branch of the third cervical nerve.

VII. EXTERNAL MOTOR NERVE.

§ 1866. The *external motor* nerve, the *sixth pair*, the *external oculo-muscular* nerve (*N. oculo-muscularis externus*, s. *posterior*, s. *abducens*, s. *par sextum*),(1) is flat, and arises by two very distinct roots, an internal and an external which is usually four times the size of the former, from the upper extremity of the pyramid, from the posterior edge and the posterior extremity of the lower face of the annular protuberance, about two lines from the median line, and four or five lines inside of the facial nerve. From the inferior face of the annular protuberance only the inner root generally arises, which sometimes does not extend to the posterior edge, but terminates two lines from this edge and arises only from the external face of this protuberance, although we cannot follow it farther either backward or forward. The external root generally arises also from the anterior extremity of the pyramid. These two roots, particularly the internal, are formed of several fasciculi which are easily detached from each other.

It is very rare that the internal root is the larger,(2) or that the filaments by which the nerve arises do not unite in two distinct roots.

Sometimes the nerve arises only from the pyramid. Not unfrequently it comes in part from the olivary body and the transverse band which is often found between the summits of the two pyramids.(3)

We can, however, generally demonstrate particularly by comparative anatomy, that it arises from the medulla oblongata between the olivary bodies and the pyramids, much lower than it comes from them and that the different filaments coming from the olivary bodies, the small transverse striæ, and the pons Varolii, are either supplementary, or as is true particularly of those from the annular protuberance, ap-

(1) Zinn, *Desc. oculi humani*, Gottingen, 1755, tab. vi.
(2) We have rarely seen this. Vicq-d'Azyr (*Mém. de Paris*, 1781, p. 589) observes also that this arrangement is rare.
(3) Vicq-d'Azyr, *loc. cit.*, p. 589.

pear to be distinct roots only because the fibres of the principal root of the nerve are separated from each other at their upper part by the posterior fibres of the pons Varolii.(1)

The two roots generally unite before passing through the dura-mater: sometimes, however, each passes through a special opening in this membrane and also proceeds three or four lines and even glides under a special fibrous bridge entirely distinct from the dura-mater before they join. In the cases where we have seen this arrangement it has *always* appeared on the left side *alone*, and the external fasciculus was the smaller.

These facts, compared with those adduced by Sœmmerring, seem much in favor of the opinion that the ganglionnary nerve comes from the centre of the nervous system, and that the cerebral nerves appear to be more numerous than they truly are by the enlargement of some branches. If proved that the external motor nerve always divides on the left side, it would be important on account of the analogy which it establishes with the vascular system.

On leaving the encephalon the nerve becomes fibrous, is covered with a neurilemma and goes directly forward and outward, passes through the dura-mater below the posterior clinoid process, enters the cavernous sinus within which it is attended a short distance by the arachnoid membrane, being separated from the blood by the inner membrane of the sinus, and is situated on the outside of the internal carotid artery to which it is attached by compact cellular tissue. In passing above the anterior orifice of the carotid canal it anastomoses with the ganglionnary nerve by some filaments which form an acute angle with its trunk. Farther forward it communicates also by a filament with the spheno-palatine ganglion, or the recurrent nerve of the second branch of the trifacial nerve. It goes to the orbit through the sphenoid fissure through a special opening in the dura-mater, enters this cavity between the fasciculi of the rectus oculi externus muscle, intimately united in this place with the common motor nerve and the nasal nerve of the first branch of the trifacial nerve, and coming on the inside of the rectus externus muscle is entirely distributed to it.

The external motor nerve goes then only to one muscle. It very rarely gives off the nasal branch of the fifth pair,(2) but more frequently sends a filament to the opthalmic ganglion.(3) This latter arrangement makes the transition from that commonly found to the first. This anastomotic filament, however, undoubtedly belongs at least in part to the ganglionnary system.

(1) Gall, *loc. cit.*, p. 204.
(2) Otto, *Seltne Wahrnehmungén*, 1816, p. 109.
(3) Petit, *Mém. de Paris*, 1727.

VIII. TRIFACIAL NERVE.

§ 1867. The *trifacial* nerve, the *fifth pair*, (*N. trigeminus*, s. *divisus*, s. *mixtus*, Gall, s. *par quintum nervorum*),(1) is very large: it appears about six lines before the posterior edge of the inferior prolongation of the cerebellum, three behind the anterior edge of this prolongation, and nine from the median line of the pons Varolii. There it is manifestly composed of three more or less distinct roots, a posterior, a central, and an anterior. The posterior is situated farther backward and higher than the central, and the anterior below and on the inside of it. These roots were first correctly described by Santorini,(2) and after him by Wrisberg,(3) Palletta,(4) and Niemeyer.(5)

§ 1868. The central root is always much larger than the other two, for it is more than a line and a half in diameter after it emerges, while each of the others is only about half a line. Its fasciculi are more numerous: but they are smaller than those of the other two roots.

At the place where it emerges it is a little depressed from above downward, but soon enlarges, becomes round, and again contracts.

The fibres of the annular protuberance evidently separate at their base, so that we may judge from a superficial examination that the root does not arise in this place but from a deeper part.

This middle root is composed of thirty or forty fasciculi of various sizes. The number of filaments which form these fasciculi is about one hundred: some authors assert less; but they probably have described the fasciculi simply as filaments, or have neglected to decompose several of them.

It is principally by following the central root that we can demonstrate very evidently that the nerve arises from a deeper part than where it leaves the annular protuberance. Santorini has stated perfectly its true origin;(6) his observations have been confirmed and

(1) J. F. Meckel, *De quinto pare nervorum*, Gottingen, 1748.—A. B. R. Hirsch, *Paris quinti nervorum encephali disquisitio anatomica*, Vienna, 1765.—H. A. Wrisberg, *Observationes anatomicæ de quinto pare nervorum et de nervis, qui ex eodem duram matrem ingredi falso dicuntur*, Gottingen, 1777.—A. C. Bock, *Beischreibung der fünften Nervenpaares und seiner Verbindung mit andern Nerven, vorzüglich dem Gangliensystem*, Meissen, 1817.—G. R. Treviranus, *Sur les nerfs de la cinquième paire, considérés comme organes ou conducteurs de sensations*; in the *Journ. compl. du dict. des sc. méd.* vol. xv. p. 207.—Magendie, *Sur les fonctions de la cinquième paire de nerfs*; in the *Journ. de phy. exp.*, vol. iv. p. 176 and 302.

(2) *Obs. anat.*, Venice, 1724, p. 65.

(3) *Loc. cit.*

(4) *De nervo crotophitico et buccinatorio*, Milan, 1784.

(5) *De origine paris quinti nervorum cerebri*, Hales, 1812.

(6) *Loc. cit.*, p. 65. The honor of this discovery then belongs to Santorini. Niemeyer seems to attribute it to Winslow, and is consequently wrong, for the *Anatomy* of Winslow appeared first in 1732, while Santorini's observations were published in 1724.

rendered still more exact by the labors of Winslow,(1) Sœmmerring,(2) Gall,(3) and Niemeyer.(4)

Here also the posterior part and the proper origin of the nerve are covered by the considerable development of the cerebral parts. On leaving the place where it appears, it enters from without inward, from before backward, and from below upward in the fissure of the central prolongation of the cerebellum, and is more or less completely divided into several cords by the transverse fibres of the annular protuberance, thus comes behind the union of the three peduncles of the cerebellum directly below the floor of the fourth ventricle, passes under the posterior prolongation of the cerebellum, almost the length of the external edge of the annular protuberance, and proceeds towards the groove between the restiform and the olivary bodies; its strongest root arises there partly from the groove and partly from the olivary eminences.

From this point to where it passes between the posterior and lateral prolongations of the cerebellum it is not fibrous, and is surrounded by gray substance; but from this second point to its emerging from the annular protuberance it is formed of very apparent fibres, and is surrounded by a thin membrane. In its whole extent from its origin to a little before its emerging on the external face of the inferior prolongation of the cerebellum it gradually becomes thicker, but before leaving the pons Varolii it slightly contracts and enlarges considerably after emerging.

The fasciculi of the nerve are then more distinct and surrounded with neurilemma, and occupy the whole circumference of the pons Varolii. They enlarge partly by the separation and partly by the increase of their substance. When once emerged, the nerve is at first round but gradually becoming flatter, goes forward towards the upper end of the petrous portion of the temporal bone. At first it is loose in the skull, being loosely surrounded by a broad prolongation of the arachnoid membrane, but at the upper edge of the petrous portion of the temporal bone it enters a rounded and oblong sheath of the dura-mater which generally is entirely separated from the cavernous sinus. This sheath is at first loose, but afterwards is placed strongly on its surface. It thus goes from before downward and from behind forward on the anterior face of the petrous portion of the temporal bone.

In this course the trifacial nerve examined externally seems formed only by fasciculi placed one at the side of another. These fasciculi, however, communicate their whole extent by small intermediate filaments. This union and the ramification of fasciculi which results from it, become more and more marked from behind forward, and for about a line and a half to two lines the breadth of the fasciculi divide into very minute

(1) *Exp. anat.*, 1732, vol. iv. p. 182.
(2) *Loc. cit.*, p. 267.
(3) *Ueber das Organ des Seele*, Koenigsberg, 1796, p. 36.
(4) *Loc. cit.*, p. 211.

filaments, and interlace perpetually with each other near its anterior extremity. The trunk of the nerve which here touches outward the last curve of the internal carotid artery anastomoses with some filaments of the great sympathetic nerve.

The anterior extremity of this large principal root suddenly differs in appearance from the other parts, and the different branches of the nerves.

In fact at the anterior extremity of the upper face of the petrous portion of the temporal bone it forms a semicircular prominence, the concave edge of which is turned upward and backward and the convex edge downward and forward. This prominence which reaches beyond the trunk of the nerve in every direction is six to ten lines long from before backward, one broad from within outward, and a line and a half high. It is termed the *semilunar ganglion* or *gangliform plexus* (*ganglion semilunare*, *plexus ganglioformis*, Vieussens; *intumescentia ganglio affinis*, Scarpa; *plexus retiformis*, Santorini; *tœnia nervosa*, Haller; *intumescentia semi-lunaris*, Wrisberg; *Agger lunatus*, Neubauer; *Armilla*, Malacarne). It is transparent and reddish, and for about a quarter to half a line has no determinate texture, if we except some filaments which pass over its two faces, particularly the inner part of the inferior: but it then reassumes its fibrous appearance, so that in the mode directly the opposite of that over the plexus the filaments unite from above downward in larger threads, and thus produce fasciculi, still forming a trunk from one and a half to two lines broad, which immediately divides into three principal branches, the upper of which forms with the crural a very acute angle, and the latter a slightly obtuse angle with the posterior. The branches, the fasciculi of which still interlace with each other, are at first broad, but they gradually become round in approaching the openings through which they pass.

The plexiform filaments of the nerve are not generally continuous with the inferior, but terminate in a channel grooved on the upper and concave edge of the ganglion. The inferior arise from all the circumference of the ganglion, and most generally extend to the upper and concave edge externally. The substance of the ganglion is homogeneous internally, and precisely similar to that of the proper nervous ganglions.

§ 1869. The *small roots of the trifacial* nerve do not contribute to form the prominence of the ganglion, although there is on the lower face of this latter, and of the large root, a groove formed by their passage.

The *superior* penetrates through a special fissure into the inferior prolongation of the cerebellum from one fourth of a line to two lines distant from the great middle root. When the two roots are very near each other they seem to enter through the same fissure: but in attentively examining we perceive this is rarely the case, even if it ever happens. The direction of the superior root in the inferior prolongations of the cerebellum is the same as that of the preceding, which proceeds below

it; we however cannot trace the former as far. Soon after emerging, it turns on the upper face and the inner edge of the large root, arrives at its lower face, and continuing to pass on, it goes gradually outward where it reunites, after passing about half an inch, with the small inferior roots. It is formed of from three to six fasciculi of different sizes.

The *small inferior root* is generally nearer the central than the superior, being often only a fourth of a line and seldom more than one line distant from it, and the rule mentioned by Palletta that they are always several lines distant cannot be admitted. They often evidently arise from the same groove. The part of the small inferior root which is contained in the cerebral substance always proceeds below the large in the same direction with it, and less distant from it than is the upper root. It is generally formed of a greater number of faseiculi than the upper, as there are about from six to eight. It leaves the annular protuberance on the lower face of the large root, and reunites with the small superior root in the manner stated, most generally, three or four lines behind the ganglionnary prominence of the large root. The trunk of the *temporo-buccal* nerve (*N. crotaphito-buccinatorius*), formed by this union, passes first under the large root, then under the ganglionnary prominence and the third branch of the fifth pair, thus goes outward and forward, and anastomosing in this course only by some inconstant filaments, first with this trunk, then with the third branch of the fifth pair, often but not always enlarges longitudinally under the plexiform ganglion, and after passing through the foramen rotundum of the basilar bone proceeds to form the temporal and buccal nerves.

These two small roots form the small portion of the fifth pair, which is whiter and harder than the large.

Their separation with the ganglion formed by the large portion is extremely curious, as it presents a repetition of the formation peculiar to the nerves of the spinal marrow.

A. FIRST PRINCIPAL BRANCH.

§ 1870. The *first branch*, the *superior* or *ophthalmic branch of the fifth pair* (*R. primus*, s. *superior*, s. *ophthalmicus*),(1) is much smaller than the other two, and arises from the upper part of the ganglion. Its direction is from below upward and from behind forward on the outer side of the cavernous sinus towards the orbit, into which it penetrates from within outward, on the outside of the common motor and below the superior motor nerve.

In this course it gives off no branches, except nearer or farther from its origin a tolerably constant twig which unites to the superior motor nerve, and another less constant which goes to the ganglionnary nerve.

(1) Rinn, *Descriptio oculi humani*, tab. vi.—Soœmmerring, in Demours, *Traité des maladies des yeux*, vol. iv., p. 32, pl. vi., fig. 1.

But it is united in all its extent by very compact cellular tissue with the superior motor nerve.

Just before entering the orbit it generally divides into two and more rarely into three twigs, which are the *nasal*, the *lachrymal*, and the *frontal* nerves. In the first case, the second branch, which is larger than the other, is the common trunk of the lachrymal and frontal nerves.

1st. The *nasal* or *naso-ciliary* nerve (*N. naso-ocularis*, s. *naso-ciliaris*), which in respect to size is between the other two, anastomoses posteriorly with some filaments of the great sympathetic nerve, and divides into two branches generally before entering the orbit.

The *external* branch (*R. ciliaris*, s. *ad ganglion*) is the smaller, and goes to the *lenticular* or *ciliary ganglion* (*ganglion lenticulare*, s. *ciliare*), which is situated on the outside of the optic nerve and forms its long root. Sometimes it anastomoses previously by one or two filaments with the common motor nerve.(1) It rarely gives off a ciliary nerve.

The *internal* branch is larger and proceeds forward and inward on the optic nerve, with which it is connected. It not unfrequently gives off some ciliary nerves which proceed along the optic nerve to the eye and enter its capsule at its posterior part, proceed between the fibrous envelop and the choroid membrane to the iris, in which they are distributed with analogous but more numerous filaments which come from the lenticular ganglion, forming with them from five to ten nerves which generally divide again into two, more rarely into three fasciculi, which we shall describe when speaking of the eye. Several filaments from the ganglionnary nerve enter the ganglion.(2)

The nerve then passes below the rectus oculi superior and obliquus major muscles, continues to proceed inward and forward, situated against the internal wall of the orbit, and soon divides into two branches, the *ethmoidal* and the *infra-trochlear* nerves.

The *ethmoidal* or *internal nasal* nerve (*N. ethmoidalis*, s. *nasalis*, Winslow, s. *ophthalmicus*, Willis, s. *nasalis internus*), re-enters the skull through the internal and anterior orbitar foramen, afterwards emerges from this cavity through one of the anterior foramina of the cribriform plate of the ethmoid bone, proceeds to the nasal fossa, sends filaments to the mucous membrane of the superior turbinated bone and of the septum, sends others to that of the frontal sinus, then glides in a groove of the nasal spine of the frontal and of the proper nasal bones, descends along the anterior edge of the cartilaginous septum of the nose to the nasal fossæ, emerges, and terminates at the tip of the nose sending filaments to its alæ, at the end of which it anastomoses

(1) Bock, *loc. cit.*, p. 11.

(2) Ribes, *Sur quelques parties de l'œil*; in the *Mém. de la soc. méd. d'ém.*, vol. vii., p. 86.—Bock, *loc. cit.*, p. 12.

with some twigs of the second branch of the fifth and the seventh pairs.(1)

The ethmoidal nerve sometimes divides into an anterior and a posterior trunk, the latter of which passes through the internal and posterior orbitar foramen, and remains in the nasal fossa.(2)

The *infra-trochlear* or *external nasal* nerve (*N. infra-trochlearis*), advances below the rectus and obliquus superior oculi muscles, along the inner wall of the orbit, passes directly below the pully, and gives off a small filament to the mucous bursa in this place, leaves the orbit, and divides in the internal angle of the eye into two principal branches, a superior and an inferior. These branches soon subdivide into twigs by which the nerve is distributed in the tunica conjunctiva, the caruncula lachrymalis, the lachrymal sac, the orbicularis palpebrarum and the frontalis muscles, and the skin of the back of the nose. It anastomoses above with the supra-trochlear nerve, then with some filaments of the facial nerve, and farther forward with the second branch of the fifth pair.

Sometimes the long root of the lenticular ganglion does not come from the nasal nerve, but from the third pair. Analogous to this arrangement but much more rare is the case where the nasal nerve comes from the sixth(3) and not from the fifth pair.

2d. The *frontal* branch or nerve (*N. frontalis*), the largest of the three branches of the ophthalmic nerve, proceeds between the other two from behind forward and from without inward on the levator palpebræ superioris muscle directly below the arch of the orbit. It is at first intimately united with the superior motor nerve.

At about its centre it sends off inward and forward a small branch which anastomoses with the infra-trochlear nerve, and which sends filaments into the frontal sinus, either directly, or indirectly by a small ganglion.

It then sends off a larger filament, the *supra-trochlear* nerve (*N. supra-trochlearis*), which proceeds along the internal wall of the orbit, passes above the pully of the obliquus major muscle, and emerges from the cavity of the orbit. This nerve, called also the *internal frontal* nerve, is reflected from below upward, distributes its twigs in the corrugator supercilii muscle, the internal and upper part of the orbicularis palpebrarum, the frontalis muscle and the skin which covers it, and anastomoses with some filaments of the infra-trochlear and the proper frontal nerve.

The continuation of the trunk, the proper frontal nerve, gives off no branch within the orbit, leaves this cavity sometimes in one root but sometimes divided into several, through one or more supra-orbitar foramina, is soon reflected from below upward on the upper edge of the orbit, and is distributed in the skin of the forehead and the vertex.

(3) Hunter, *Observations on different parts of animal economy*, London, 1792.—*A description of some branches of the fifth pair of nerves*, p. 265.
(2) Bock, *loc. cit.*, p. 18.
(3) Otto, *Seltne Beobachtungen*, Breslau, 1816, p. 108.

3d. The *lachrymal* nerve, (*N. lachrymalis*) which is between the other two in size, and is the most external of the three twigs of the first branch of the fifth pair, goes forward and outward, being also situated against the orbitar plate, and soon divides into an external and an internal branch.

The *external* reunites with a twig of the subcutaneous malar nerve, which comes from the second principal branch of the fifth pair. From this trunk we generally see a filament depart which is sometimes double, and which passing directly to the anterior extremity of the inferior orbitar fissure, between the malar and sphenoid bones, goes outward in the temporal fossa, where it anastomoses with a malar branch of the facial nerve, more rarely with the superficial temporal nerve which comes from the second principal branch of the fifth pair.(1)

This external branch sometimes sends a filament to the ciliary nerves, which come directly from the nasal nerve.(2)

The *internal* branch divides into several twigs, which anastomose with each other like a plexus, and enter the lachrymal gland.

These twigs are not distributed entirely in the gland. Some, after passing through it, come outwardly, where they are distributed, partly in the external part of the orbicularis palpebrarum muscle, partly in the integuments of the malar region, and anastomose with some filaments from the posterior branches of the facial, the frontal, and the subcutaneous malar nerves.

B. SECOND PRINCIPAL BRANCH.

§ 1871. The *second principal branch of the fifth pair*, the *middle branch*, the *superior maxillary* nerve (*R. quinti paris secundus*, s. *medius*, s. *N. maxillaris superior*),(3) is between the other two in its situation and volume. It arises from the anterior part of the ganglionnary plexus ; it goes almost directly forward, or at least a little oblique from below upward, gives off no branch within the skull, although it sometimes anastomoses there with a filament of the ganglionnary nerve,(4) and emerges from this cavity outward and forward through the great foramen rotundum of the sphenoid bone. It is flat, but after emerging it becomes round.

Some distance from the place where it leaves the skull, the superior maxillary nerve gives off a small branch, the *subcutaneous malar* nerve (*N. subcutaneus malæ*), which reascends in the spheno-maxillary fissure. This branch enters into the orbit below the rectus externus oculi muscle, and anastomoses by one or more filaments with

(1) Bock, *loc. cit.*, p. 19.
(2) Bock, *loc. cit.*, p. 20.
(3) J. F. Meckel, *De quinto pare nervorum ;* in Ludwig, *Opp. min.*, Gottingen, 1817.—A. Scarpa, *Annot. acad.*, l. ii., Modene, 1779. cap. iv. v. vi. tab. i. ii.
(4) Laumonier, in Roux, *Journ. de méd.*, vol. xciii. p. 259.

the external twig of the lachrymal nerve. It sends off, farther forward, one or more ramifications, which enter into the lachrymal gland; some of them remain in its tissue, while others, after passing through it, emerge from the orbit and are distributed in the orbicularis palpebrarum muscle and the skin of the cheek, where they communicate with some filaments of the facial nerve and of the third principal branch of the fifth pair. Finally, the subcutaneous malar nerve emerges from the orbit through the malar foramen, sometimes in one trunk, and sometimes divided into several filaments. It is distributed on the face to the lower part of the orbicularis palpebrarum muscle, and also to the skin of the malar region, and communicates with the twigs of the facial and infraorbitar nerves.

The superior maxillary nerve then divides into two much larger and nearly equal branches, which proceed almost directly from above downward. They are the *pterygo-palatine* and the *infraorbitar* nerves.

The *pterygo-palatine* nerve (*N. pterygo-palatinus*) sometimes forms a single trunk, sometimes arises by two or three distinct filaments, which become the roots of a small rounded triangular or cordiform ganglion, situated on the outside of the spheno-palatine foramen, and termed from its discoverer, the *ganglion of Meckel* (*G. Meckelii*),(1) and also the *spheno-palatine* ganglion (*G. spheno-palatinum*). The *recurrent* and *palatine* nerves come from this ganglion.

The branches coming from the pterygo-palatine ganglion, vary according as the spheno-palatine ganglion does or does not exist.

If it exists, the *upper anterior nasal* nerves partially arise from the trunk of the pterygo-palatine nerve, partly from the palatine nerve, and the naso-palatine nerve comes from the pterygo-palatine.

Several small branches come from the trunk of the pterygo-palatine nerve, and from the spheno-palatine ganglion when they exist.

First arises a filament which enters the sphenoidal sinus, or which, when it is very much developed, passes through this cavity and goes to the external motor nerve, with which it anastomoses;(2) sometimes it sends ramifications to the sphenoidal sinus, and also to the posterior and most superior part of the septum of the nasal fossæ.

Next come four or five filaments which are a little larger; they pass through the dura-mater, which is extended on the pterygo-palatine foramen, are distributed in the mucous membrane which lines the posterior part of the upper and middle turbinated bones of the nose, and anastomose with the ramifications of the olfactory nerve. They are the *upper anterior nasal* or the *spheno-palatine* nerves (*N. nasales superiores et anteriores*). Farther on are the *nerve of the septum*, which will be described more properly after the naso-palatine nerve, and the

(1) J. F. Meckel, *Observation anatomique sur un nœud ou ganglion du second rameau de la cinquième paire des nerfs du cerveau nouvellement decouvert avec l'examen physiologique du veritable usage des nœuds ou ganglions des nerfs*; in *Mém. de Berlin*, 1749. p. 84, 103. tab. iii.

(2) Bock, *loc. cit.*, p. 26.

upper posterior nasal nerves, which, however, are more frequently branches of the recurrent nerve.

The pterygo-palatine nerve then divides in the summit of the pterygo-palatine fossa, into a *recurrent* and a *descending* branch.

The *recurrent* branch, the *pterygoid* or *vidian* nerve (*N. quinti recurrens*, s. *anastomoticus*, s. *pterygoideus*, s. *vidianus*), is so termed from its direction; for it goes backward, enters into the pterygoid foramen, and anastomoses by several filaments with the facial and great sympathetic nerves.

This nerve gives off first inward and downward, two or three filaments termed the *posterior* and *superior nasal* nerves (*N. nasales posteriores superiores*), which sometimes unite in a small trunk, termed by Bock, the *pharyngœal* nerve (*R. pharyngœus*). These nerves emerge sometimes through the lower part of the spheno-palatine foramen, sometimes pass through the inner wall of the pterygoid canal, penetrate inward through the pterygoid process, and are distributed in the posterior part of the mucous membrane of the nose, where they anastomose with the ramifications of the olfactory nerves in the muscles of the velum palati, the skin of the soft palate, and around the anterior orifice of the Fallopean tube.

The external part of the nerve which is remarkable for its softness and reddish color, then divides, before leaving the pterygoid canal into two branches, which sometimes remain distinct to the ganglion, and by which it terminates.

These two branches are the anastomotic nerves. The smaller *superior* or *superficial* nerve is the *superficial petrous* nerve (*N. petrosus superficialis*). It proceeds generally single, seldom divided, through the fibro-cartilage, situated between the sphenoid bone and the petrous process, goes backward, upward, and outward, under the third principal branch of the fifth pair, in a groove on the upper face of the petrous process, leaves this groove and enters the Fallopian canal, anastomoses here with the facial nerve which passes through it, and sometimes sends filaments to the branches of the ganglionnary nerve which surround the upper part of the carotid artery like a plexus.(1)

The *inferior* or *deep*, the larger, proceeds in the same direction as the recurrent nerve, emerges from the posterior extremity of the pterygoid canal through the fibro-cartilage, between the sphenoid bone and the petrous process, goes outward and backward, passes through the dura-mater, and goes into the carotid canal, where it anastomoses with the upper extremity of the ganglionnary nerve, conjointly with a filament of the sixth pair, thus forming a very constant and very evident anastomosis between the fifth pair and the great sympathetic nerve.

The differences sometimes observed in this respect will be more in place in the description of the great sympathetic nerve. In fact, it is probably more correct to consider the deep branch of the recurrent nerve as a ramification of this latter.

(1) Bock, *loc. cit.*, p. 28.

The *descending* branch or the *palatine* nerve (*N. palatinus*) is much larger than the recurrent, and is distributed to the middle and lower part of the mucous membrane of the nose, and also to the membrane of the palate. It is then more properly termed the *naso-palatine* nerve (*N. naso palatinus.*)

From this, or from the spheno-palatine ganglion, or finally from the trunk of the pterygo-palatine nerve, arises first the *nerve of the septum of the nose* (*N. septi narium*), which Scarpa(1) less properly terms the *naso-palatine* nerve (*N. naso-palatinus*).(2)

This nerve enters the nose with the anterior and superior nasal nerves, through the spheno-palatine foramen, proceeds from without inward, passing before the sphenoidal sinus towards the septum on which it descends from behind forward, between the periosteum and the mucous membrane, to the anterior palatine foramina, farther forward on the left than on the right side, and thus arrives at the membrane of the palate. In passing through the palatine canal the nerves of the two sides unite, sometimes form a small prominence termed the *naso-palatine* ganglion (*G. naso-palatinum*), and expand on a prominence situated below the anterior palatine foramen.

The palatine nerve then divides into a large anterior branch, the continuation of the trunk, and two or three smaller and posterior, all of which descend into the pterygo-palatine fossa. These branches are the *great* and *small palatine* nerves (*N. palatini major et minores*). They sometimes arise directly from the ganglion, or even, as is true particularly of the smallest, from the second principal branch.

From the anterior part of the great palatine nerve arise first the *middle* and *inferior posterior nasal* nerves (*N. nasales posteriores medii et inferiores*).(3)

The *posterior middle nasal* nerve soon divides into two branches, which are sometimes separate at their origins. The superior goes directly forward in the mucous membrane of the middle turbinated bone. The second goes to the upper part of that of the inferior turbinated bone.

The *posterior inferior nasal* nerve arises much lower, opposite the posterior extremity of the lower turbinated bone, towards which it proceeds directly, and sends its filaments into the mucous membrane which lines the inner face of this bone anteriorly.

These two nerves anastomose with the ramifications of the olfactory nerve.

The anterior branch of the great nasal nerve sends directly backward a small twig, which passes through the pterygoid process in a special canal, and is distributed to the glandular substance of the soft palate.

(1) *Loc. cit.*, cap. v. *De nervo palatino.*
(2) Scarpa, *loc. cit.*, tab. i.—Hunter, *Observations on different parts of the animal economy*, tab. xvii.
(3) Cloquet, *loc. cit.*, vol. ii. p. 687.

The branch, the fasciculi of which separate from each other, goes forward and downward in the pterygo-palatine canal, and comes through the posterior palatine foramen to the lower face of the bony palate, where it immediately divides into three or four considerable branches which proceed between the mucous membrane and the periosteum, along the inner face of the alveolar processes opposite the teeth, and are distributed in the gum.

The two or three *small palatine* nerves descend behind the great palatine nerve, first in the pterygo-palatine fossa, then lower in small special canals of the petrous portion of the temporal bone, on emerging from which, they enter into the amygdalæ, the palato-staphylinus muscle, the muscular and glandular substance of the soft parts of the palate and the uvula.

§ 1872. The *infraorbitar* nerve (*N. infraorbitalis*), the second of the two branches in which the superior maxillary nerve divides, is directed from behind forward, from within outward, and from above downward, in the spheno-maxillary fissure, and goes to the infra-orbital canal.

But before entering into this canal, it sends off a considerable branch called the *dentar* or *posterior superior alveolar* nerve (*R. dentalis*, s. *alveolaris posterior superior*). This nerve divides sometimes even at its origin, sometimes afterward, into two branches, an anterior which is smaller, and a posterior which is larger.

The *posterior* descends on the posterior part of the external wall of the maxillary sinus, below the temporalis muscle, which enters into this cavity through its posterior wall, is distributed in its mucous membrane,(1) and there anastomoses with the anterior dentar nerve. It terminates by some superficial ramifications which go to the buccinator muscle, and by deeper twigs which enter into small canals grooved in the posterior part of the body of the superior maxillary bone, and penetrates into the roots of the three large posterior molar teeth. Each root receives one of them. We see one of them also between each two molar teeth, which goes into the gum.

The *anterior* branch is distributed principally in the upper and posterior part of the buccinator muscle.

After giving off the upper and posterior dentar nerve, the infra-orbitar nerve enters into the infra-orbitar canal.

In passing through this canal it usually gives off, sometimes sooner and sometimes later, several branches, but always one at least, which is larger than the others even when they exist; these are the *anterior dentar* nerves (*N. dentales anteriores*) which enter into the superior maxillary bone, send some filaments into the nose at the anterior part of the inferior turbinated bone, anastomose by several filaments with the posterior dentar nerves, pass forward on the roots of the anterior teeth, and terminate by ramifications which go to the incisors, the ca-

(1) Bock asserts that the nerve is not distributed to the membrane of the maxillary sinus; but we have several times clearly seen filaments arising from it.

nine, and the anterior molar teeth, and to the gum. Those which belong to theincisors and the canine teeth arise directly from the anterior dentar nerve; those of the anterior molar teeth from the union of this nerve with the posterior dentar nerve.

The infra-orbitar nerve then emerges from the canal through the infra-orbitar foramen, within which it divides into two principal branches, an internal and an external, and sometimes even in all the other subordinate branches. It thus comes on the face, where it divides into a considerable number of ramifications, which terminate in the skin and the muscles of the nose and upper lip, and anastomose with those of the first principal branch of the fifth pair, and also with some filaments of the facial nerve.

The two principal branches usually subdivide into six or seven twigs, which may be distinguished into *superior*, *anterior*, and *inferior*.

1st. *Superior* branch. There is usually only one superior twig, the *inferior palpebral* nerve (*N. palpebralis inferior*). This nerve, the first given off by the infraorbitar nerve, from which it is sometimes separated even within this canal, and which often emerges through a special foramen situated more internally than the infra-orbitar, immediately ascends from without inward towards the lower part of the orbicularis palpebrarum muscle, and divides into an external and an internal twig.

The *external* goes outward towards the external angle of the eye, on the lower part of the orbicularis palpebrarum, and gives off filaments to this muscle. It anastomoses with those of the internal twig, and with the temporal branches from the facial nerve.

The internal goes to the inner angle of the eye, gives a twig to the skin of the nose which descends to the end of this organ, where it anastomoses with the nasal twig of the first principal branch of the fifth pair. It afterwards anastomoses in the lower eyelid with the external twig and with a filament of the infra-trochlear nerve, and terminates in the orbicularis palpebrarum muscle, the integuments of the lower eyelid, the caruncula lachrymalis, and the lachrymal sac.

2d. *Anterior* or *nasal twigs*. The twigs which go forward, and also at the same time a little outward, are the *superficial* or *cutaneous nasal* nerves (*N. nasales superficiales*), which may be distinguished into an *internal superior*, and an *external inferior*.

The *internal superior*, generally the smaller, is reflected upward under the levator palpebræ superioris muscle, often gives origin to the preceding, and then divides into two or three filaments which proceed forward below this muscle along the centre of the nose, send their ramifications into the levator labii superioris alæque nasi, and the depressor alæ nasi muscles, and the integuments of the middle and inferior parts of the nose. They extend to the back and tip of this organ, and anastomose in the latter place with the nasal twig of the first principal branch of the fifth pair.

The *external* and *inferior* descends under the levator labii superioris muscle, often sends an ascending filament to the lower eyelid and to the lower part of the orbicularis palpebrarum muscle, then continues its course from above downward, often receives a filament from the preceding, goes forward to the ala of the nose above the levator labii superioris alœque nasi muscle, sends ramifications to this muscle and to the middle and upper parts of the orbicularis oris, and terminates at the lower part of the septum and of the top of the nose, where it anastomoses with the nasal twig of the first principal branch of the fifth pair.

3d. *Descending* or *labial twigs.* The descending twigs are generally three or four *superior labial* nerves (*N. labiales superiores*), they succeed one another from before backward. They are distinguished into *internal*, *middle*, and *external.* All descend from before backward, covered by the levator labii superioris muscle, are distributed in this muscle, the skin of the upper lip, the corresponding part of the orbicularis oris, and the lower part of the zygomatici and the buccinator muscles. They even penetrate through the orbicularis oris muscle, and go to the buccal membrane and the glands of the upper lip.

3d. We frequently find also an external twig of the infraorbitar nerve, the *external palpebral* nerve. This very small twig passes through the levator labii superioris muscle, goes outward, where some of its filaments are distributed in the orbicularis palpebrarum muscle, and others anastomose with filaments of the facial nerve.

C. THIRD PRINCIPAL BRANCH.

§ 1873. The *third principal branch*, the *inferior* or *posterior branch of the fifth pair*, the *inferior maxillary* nerve (*R. quinti paris tertius*, s. *inferior*, s. *posterior*, s. *nervus infra-maxillaris*),(1) which is by far the largest, arises from the lower and posterior part of the ganglionnary plexus, and is formed principally by the small anterior portion, whence Palletta(2) considers it a distinct nerve. It is the shortest of the three within the skull, and goes from above downward, and slightly also forward and outward, and enters the round foramen of the sphenoid bone, after anastomosing in this course with some inconstant filaments, with the cavernous ganglion of the sympathetic nerve. (3)

The *inferior maxillary* nerve is distributed to the muscles, the integuments, and the teeth of the lower jaw, the lower lip, the lower salivary glands, and the tongue.

It is covered where it emerges from the cranium, by the pterygoideus externus muscle, and soon divides into two large branches, an upper and anterior, and a lower and posterior. This bifurcation however is

(1) A. F. L. Fitzau, *De tertio ramo paris quinti nervorum cerebri s. nervi maxillari inferiori*, Leipsic, 1811.
(2) *De nervis crotaphitico et buccinatorio*, Milan, 1784.
(3) Laumonier, *loc. cit.*—Munniks, *De origine nervi intercost.* in *Obs. var.*, Groningen, 1805.

not constant, for sometimes the twig formed by the two branches comes directly from the trunk.

§ 1874. The *upper anterior* branch is much smaller than the other, divides soon after and even before emerging from the skull, into five twigs, which separate from each other like rays. They are the *masseteric*, the *internal* and *external deep temporal*, the *buccal* and the *pterygoid* nerves.

The *masseteric* nerve (*N. massetericus*), the most external, which generally arises the highest, pursues a transverse direction from within outward, directly before the articular surface of the temporal bone, on the outside of the pterygoideus externus muscle, where it sends filaments to the ligaments of the temporo-maxillary articulation, and to the lower part of the temporalis muscle, then descends from within outward between this muscle and the pterygoideus externus muscle, goes to the sigmoid fissure of the lower maxillary bone, and passing behind the tendon of the temporalis muscle, glides between the two layers of the masseter, in which it is almost entirely distributed.

The second twig, the *external deep temporal* nerve (*N. temporalis profundus externus*), arises farther forward and inward, often comes from the preceding or from the buccal nerve, and sometimes from a common trunk with the following. It goes outward under the pterygoideus externus on the temporalis muscles, commonly anastomoses with the following and by an intermediate filament, and goes immediately upward and inward to enter the temporalis muscle.

The third twig, the *deep internal temporal* (*N. temporalis profundus internus*), is generally larger than the preceding, and follows the same course. It is distributed also in the temporalis muscle, but also sends some anastomotic filaments to the buccal nerves. It also gives off others farther forward which go to anastomose with the cutaneous malar and with the lachrymal nerve on the outside of, and sometimes even within, the orbit: the existence however of these last two anastomoses has been doubted, since the researches of Bock, who regards the filaments generally considered as such, as ramifications of the arteries.(1)

The fourth twig, the *buccinator* or *buccal* nerve (*N. buccinatorius*), is usually the largest of the five, and sometimes the trunk of the three preceding. It goes forward between the two pterygoidei muscles and through the external, sends filaments to these two muscles, particularly the external, arrives at the lower part of the temporalis muscle, then descends between this latter and the pterygoideus externus, comes on the external face of the buccinator, is distributed mostly to this muscle, passes through it to send some filaments to the membrane and to the buccal glands, anastomoses with the anterior branches of the facial nerve, and terminates in the levator and depressor anguli oris muscles.

(1) Bock, *loc. cit.*, p. 44.

The fifth twig, the *pterygoid* nerve (*N. pterygoideus*), is the smallest. It arises from the inner part of the superior branch, passes between the pterygoideus externus and peristaphylinus muscles and arrives at the upper part of the pterygoideus internus, to which it is entirely distributed.

§ 1875. The *posterior* and *inferior* branch is much larger than the preceding and the proper continuation of the trunk, divides soon after arising into three twigs, the *superficial temporal*, the *inferior dentar*, and the *lingual* nerve.

The *superficial temporal* nerve (*N. temporalis superficialis*) most generally arises by two more rarely by three roots, and still more rarely by one. Of these two roots, the inferior, the smaller, comes from the inferior dentar nerve and reunites with the superior, so that the spherospinous or middle cerebral artery passes between them.

The trunk goes from within outward on the inside of the temporomaxillary articulation between the condyle of the jaw and the lateral ligament, and here divides in five or six branches. Two or three of these branches penetrate from without inward and from behind forward in the parotid gland, and anastomose with this trunk and with some ramifications of the facial nerve. One or two of the others, which may be termed the *nerves of the external auditory passage* (*N. meatus auditorii externi inferior*, s. *superior*), go backward, pass through the anterior wall of the osseous portion of the auditory passage, and pass between this and the cartilaginous portion: Their ramifications are distributed some in the integuments of the inner part of the external ear, and others in those of the auditory passage. We see also one of them which goes to the membrane of the tympanum, glides between its two layers, and anastomoses by one or two filaments with the cord of the tympanum.(1)

The last and largest branch of the superficial temporal nerve passes through the parotid gland to the external ear, and terminates in the integuments of the central part of the cranium by anastomosing with some filaments of the great occipital and the frontal nerve of the first principal branch of the fifth pair. It also communicates with some filaments of the external lachrymal twig and of the cutaneous malar nerve which go outward.

The other two nerves given off by the posterior and inferior branch of the infra-maxillary nerve at first form only a single but very short trunk.

The *inferior dentar* nerve (*N. alveolaris maxillæ inferioris*, *N. maxillaris inferior*), which is situated between the other two twigs of the posterior branch which is generally the largest ramification given off by the trunk of the inframaxillary nerve, sometimes arises by two roots which embrace the internal maxillary artery. It descends from within outward and from behind forward, first between the two ptery-

(1) Bock, *loc. cit.*, p. 49.

goidei muscles, then between the external and the condyle of the jaw. Near its origin it gives off a small and very constant branch, the *mylo-hyoid* nerve (*N. mylo-hyoideus*), which descends from behind forward in a channel grooved in the inner face of the branch of the jaw, sends a twig to the submaxillary gland, goes towards the lower face of the mylo-hyoideus muscle, proceeds from behind forward between this muscle and the anterior belly of the digastricus, gives some filaments to both of them but particularly to the mylo-hyoideus muscle, and after being reflected from below upward on the lower edge of the lower jaw, is distributed in the muscles of the chin.

The trunk of the inferior dentar nerve proceeds from behind forward in the inferior dentar canal. But it generally divides on entering into two branches, a superior which is smaller, the *dentar* nerve (*N. dentalis*), and an inferior and larger, the *mental* nerve (*R. mentalis*); these proceed at the side of each other, and communicate by numerous anastomosing filaments.

The *dentar* branch is situated below the teeth, and sends a filament to each of them and to each root of the molar teeth. All these filaments arise farther back than the teeth to which they proceed: between each two teeth it sends a filament to the gum.

The mental branch emerges through the mental foramen. It soon divides under the levator anguli oris muscle into two twigs, the *inferior labial nerves* (*N. labiales inferiores*), the internal of which is larger in a greater or less degree than the external.

The direction of the external is upward; it sends some filaments to the levator anguli oris muscle, but principally to the lower part of the orbicularis oris, the glands of the lower lip and the buccal membrane, and anastomoses with some filaments from the inferior branches of the facial nerve.

The *internal*, covered by the depressor labii inferioris muscle, goes forward and upward, sends filaments to this muscle, to the levator menti, the central part of the orbicularis oris, the skin of the chin, the glands of the lower lip, and the buccal membrane, and anastomoses with the marginal branch of the facial nerve.

The *lingual* nerve (*N. lingualis*, s. *gustatorius*), the most anterior of the three twigs of the lower and posterior branch of the inframaxillary nerve is between the other two in respect to size. It arises farther inward than they, and is frequently united to a considerable extent in a common trunk with the preceding. It descends with it from behind forward, usually on the inside of the internal maxillary artery, separates from the inferior dentar nerve and goes inward, receives before the palatostaphylinus and pterygostaphylinus muscles, and behind the pterygoideus externus, the cord of the tympanum, which unites with it at a very acute angle, then passes before the inferior dentar nerve, sometimes sends to the pterygoideus internus muscle a filament which is often detached above the anastomosis with the cord of the tympanum, enters between the pterygoideus internus and the ascending branch of the jaw, and passing above the submaxillary gland, gives to it as high

as the angle of the jaw several considerable filaments, which come sometimes directly from its trunk, sometimes from a small ganglion which it forms on it, and which is called the *maxillary ganglion* (*ganglion maxillare.*)

These filaments are distributed principally in the gland. Generally however one of them emerges from it, descends on the hyoglossus muscle, anastomoses with a branch of the lingual nerve, and terminates in the genio-glossus muscle.

The trunk of the lingual nerve then goes forward between the hyoglossus and mylo-hyoideus muscles, passes between the sublingual gland and the hyoglossus muscle having before it the excretory duct of the submaxillary gland, anastomoses by several considerable filaments which come from its inner side with the hypoglossal nerve, sends some which are very minute to the buccal membrane and larger ones to the sublingual gland, and divides into seven or eight branches which proceed from behind forward and from below upward between the styloglossus and genio-hyoideus muscles. These branches separate like the sticks of a fan, and go principally to the edges and tip of the tongue and are there distributed by minute filaments in the skin of this organ.

IX. INTERNAL MOTOR NERVE.

§ 1876. The *superior* or *internal motor* nerve, the *pathetic*, the *fourth pair*, the *internal oculo-muscular* nerve (*N. oculo-muscularis superior*, s. *minimus*, s. *musculi oculi obliqui superioris*, s. *par cerebrale quartum*, s. *N. patheticus*),(1) the smallest cerebral nerve, generally arises by an anterior and a posterior root, each composed of one filament about the same size. They are frequently half an inch apart, but united by cellular tissue. They arise directly behind the external half of the posterior part of the tubercula quadrigemina from the anterior and external part of the upper face of the cerebral valve, so that the anterior arises from some transverse medullary fibres which cover the valve in this place, and which unite them on the median line with those of the opposite side. This nerve seldom has three roots and still more rarely one only.

After arising, it goes downward and a little forward, first on the upper extremity of the anterior prolongations of the cerebellum, then about two lines from the anterior edge of the occipital protuberance, first on the lateral and then on the lower face of the cerebral peduncle. After proceeding much farther within the skull than any other encephalic nerve, it comes to the posterior clinoid process. There it enters into a special canal of the dura-mater, the internal wall of which is very thin and separates it from the cavernous sinus, usually anastomoses there with the first branch of the trifacial nerve by a small fila-

(1) Zinn, *loc. cit.*—Sœmmerring, in Demours, *loc. cit.*, vol. iv. p. 31, pl. vi., fig. 1.

ment, and is situated first below the eommon motor and the ophthalmic nerves. At the sphenoidal fissure it is situated above the first of these two nerves, enters into the orbit through the upper and internal part of this fissure, and its direetion there is from behind forward and from without inward direetly under the periosteum, attended by the frontal twig of the ophthalmic branch of the fifth pair, and enlarges mueh in this course. Finally it enters the obliquus oeuli superior muscle at about its centre.

X. COMMON MOTOR NERVE.

§ 1877. The *common motor* nerve, the *common motor of the eye*, the *third pair*, the *common oculo-muscular* nerve (*N. oculo-muscularis inferior*, s. *medius*, s. *oculo-motorius communis*, s. *par tertium*),(1) a considerable trunk generally the fourth in size and rarely the third among the encephalie nerves, arises about two lines before the anterior edge of the annular protuberanee on the inner faee of the cerebral pedunele about two lines above its lower edge, at the plaee where the gray cribriform plate whieh eovers the inner faee of the pedunele eommenees. It even arises in great part from this layer. Some smaller filaments eoming from near the internal edge of the lower faee of the cerebral peduncle usually join this root, whieh is single and very large.

It is however easy to follow the origin of the nerve farther upward and backward, for beyond the point where it leaves the annular protuberanee it is eovered anteriorly only by a very thin layer of gray substanee of whieh we pereeive no traee posteriorly. When this substance is removed, when the annular protuberanee is divided, turned from above downward, and carefully eut longitudinally on the median line, we observe that a medullary layer commenees at the plaee where the nerve emerges, continues with its fibres, and terminates like a fan upward and a little forward, forms a fascieulus whieh is rounded posteriorly although straight at first, and eurves from below upward.

The anterior and flat part of this layer extends to the bottom of the groove existing between the two eerebral peduneles. Its posterior parts are arranged in faseieuli, eonverge from before baekward, and are blended at their posterior part. The anterior part is loose, but in order to see the posterior we must separate the anterior half of the annular protuberanee and turn over the two folds. The posterior part of this medullary layer then rises directly below the floor of the aqueduet of Sylvius.

The two nerves are at first attached to eaeh other by their inner faces, so that they slightly resemble the arrangement of the optic nerves. After leaving this point, where they are detaehed from the encephalon, they proceed from within outward and from before back-

(1) Zinn, *loc. cit.*—Sœmmerring, in Demours, *loc. cit.*, vol. iv. p. 34, pl. vi. fig. 2.

ward, arrive at the external wall of the cavernous sinus, are situated within and above the first branch of the trifacial and the superior motor nerves; then changing this direction below and on the outside of these nerves they pass through the dura-mater which closes the sphenoidal fissure, and enter the orbit with the external motor and the nasal branch of the trifacial nerve.

Before passing through the dura-mater, the common motor nerve is divided into a superior and an inferior branch.

The *superior*, the smaller, goes inward and forward, passes on the optic nerve and the nasal twig of the ophthalmic branch, anastomoses with this latter, sends its twigs into the rectus oculi superior muscle, and passes through it to be distributed in the levator palpebræ superioris muscle.

The *inferior* is much larger than the preceding, and passes below and on the outside of the optic nerve, between it and the rectus oculi inferior muscle. It usually divides into three twigs, an *internal*, which is larger, which goes to the rectus internus muscle; a *middle*, which is shorter, for the rectus inferior muscle, and an *external inferior* branch, which is the longest and thinnest, and which goes to the obliquus inferior muscle, and the lenticular ganglion.

This latter gives off near its origin a short filament, which, situated on the outside of the optic nerve, goes to the posterior extremity of the lenticular ganglion, and forms its short root. This filament is always composed of several threads, arises more rarely from the lower branch, but sometimes also it comes at the same time from the external twig, from the middle, and even from the trunk of the lower branch.(1)

Sometimes, but very rarely, the long root of the lenticular ganglion also arises from the common motor nerve.(2)

XI. OPTIC NERVE.

§ 1878. The *optic* or *ocular* nerve, the *second pair* (*N. opticus*, s. *visorius*, s. *par secundum*), the largest of the encephalic nerves arises by a broad and flat portion from the posterior part of the external face, and also from the upper face of the optic bed and the tubercula quadrigemina. Its anterior part, which is the broadest, leaves the upper face of the optic bed, from the substance of which it is easily distinguished on account of the transverse direction of its medullary fibres, to pass on its anterior and external tubercle. The posterior passes below the posterior and external tubercle, and is attached in this place to the tubercula quadrigemina, particularly the posterior, by a medullary band, which goes forward from these latter, passing below the posterior and external tubercle of the optic bed. Thence the optic nerve proceeds from behind forward and from without inward, and descends on the lower face of the cerebral peduncle, with which it is so

(1) Bock, *loc. cit.*, p. 12.
(2) Morgagni, *Ep. anat.*, xvi. § 59.—Meckel, *De quinto pare*, § 48.

closely connected that we must admit that it partly arises from this prolongation, although separated from it in almost all its extent by the pia-mater. It gradually becomes narrower, but thicker and more rounded, and unites at an obtuse angle with that of the opposite side on the median line, on the lower face of the cerebrum, below the floor of the third ventricle. The union is so intimate that the two nerves form only one medullary mass. This mass itself has the form of an elongated square, which differs in different subjects, as is indicated in Morgagni(1) and Wenzel,(2) nor has it always the same volume.(3) It receives above some medullary fibres from the floor of the third ventricle, so that we are authorized to think that the optic nerve partially arises from this point.

After this union the two optic nerves separate and go forward and outward. Hence, when we view their place of union and their anterior and posterior parts, they represent the form of an X or of a cross. Thus, their decussation has been termed the *intercrossing* (*chiasma*). It is very rare, and perhaps never the case, that the two nerves do not unite,(4) or that by an arrangement, perhaps the opposite of the preceding, a small pointed protuberance comes from the anterior edge of the decussation.(5)

Opinions vary in regard to the manner in which the optic nerves unite. Some assert that they are only fitted to each other,(6) others that they entirely intercross, and that of the right eye, for instance, passes to the left side of the body behind the decussation.(7) Finally, some think that there is only a partial decussation, an intercrossing of most of the fibres,(8) that the external fibres of each nerve are situated on the same side of the body before as behind the decussation, while the internal intercross with the corresponding fibres of the opposite side, and pass to the other side of the body.(9)

Those who maintain the first hypothesis, assert,

1st. That on examining the decussation in the recent state, the fibres of the nerve are seen to pass through its external edge, but do

(1) *Ep. anat.*, xvi. § 13.
(2) *De penit. struct. cerebri*, p. 110.
(3) *Ibid.*
(4) Vesalius, *De corp. hum. fab.* l. iv. c. iv.
(5) Sœmmerring, in Nœthig, *De decussatione nervorum opticorum*, Mayence, 1780.
(6) Gallen, *De util. part.*, lib. x. c. xii.—Also a great number of his successors, mentioned in Nœthig.—Zinn, *Desc. oc. hum.*, Gottingen, 1765, p. 190.—Vicq-d'Azyr, in the *Mém. de Paris*, 1781, p. 554.—Meckel, in Haller, *Grundriss*, p. 386.
(7) This opinion was supported before Galen, as he refutes it (*loc. cit.*); those who have defended it since, are cited by Morgagni (*Ep. anat.*) and by Sœmmerring, in Nœthig, *loc. cit.*, and *Denksder Münchner Akad.*. 1808, p. 60.
(8) Michælis, *Ueber die Durchkreuzung der Schnerven*; in Grosse, *Magazin zur Naturgeschichte des Menschen*, vol. ii. part i. p. 149.
(9) Ackermann, in the *Med. bibl.* of Blumenbach.—Wenzel, *Locus unionis nervorum opticorum*; in *De pen. str. cereb.*, cap. xi. p. 109.

not leave their side, while the middle part is absolutely homogeneous, and presents no trace of fibrous structure.(1)

2d. That the two optic nerves have been found entirely distinct from each other, and the sight was unimpaired.(2)

3d. That where the optic nerve wasted after the loss of an eye, the change in the texture was seen only in the nerve of the same side, behind the decussation,(3) and that it is very easy to distinguish in this latter the two nerves from each other, by their color and other properties.(4)

The partisans of the second opinion state,

1st. The normal appearance.(5)

2d. Those cases where the origin of one optic nerve, or the part of the two nerves behind the decussation has been found unusually large or small, and the nerve of the opposite side presented the same character before the decussation,(6) while the sight was unaffected.

3d. The cases in which the disease of the nerve before the decussation extended behind it only to the nervous cord of the opposite side, and affected even the corresponding cerebral portions of this side.(7)

4th. The analogous cases where the origin of one of the two nerves was affected, and the functions of the eye of the opposite side were deranged.(8) Sometimes only this origin was diseased, and not the portion of the nerve on the other side of the decussation.(9)

5th. The analogy with several animals, particularly with most fishes, the nerves of which evidently intercross and enter each other.

The third hypothesis is supported,

1st. By the anatomical examination of the parts in the normal state.(10)

(1) Vicq-d'Azyr, *loc. cit.*—Wenzel, p. 111, 115. This anatomist admits that a small portion of the inner part proceeds to the opposite side before they unite; but as he expressly remarks that he has been unable to discover any fibre in this internal part, the preceding sentence does not favor the decussation, since the direction he allows to the fibres is only that of the whole nerve.—Caldani (*Mem. delle soc. ital.*, vol. xii. part ii. p. 28) has found the optic nerves united behind the decussation by a transverse medullary band.

(2) Vesalius, *loc. cit.*—Nicolas de Janua, in Caldani, *Opusc. anat.*, Padua, 1803, p. 40.

(3) Vesalius, *loc. cit.*—Cesalpino, in Riolan, *Anthopogr.*, l. iv.—Cheselden, in the *Phil. trans.*—Santorini, *Obs. anat.*, c. iii. p. 63, 64.—Meckel. in Haller, *Grundriss*, p. 386.—Caldani, *Opusc. anat.*, p. 33 and 35: two cases.—Id., in *Mem. delle soc ital.*, vol. xii. plate ii. p. 27.—Burns, *Anatomy of the head and neck*, Edinburgh, 1811, p. 359.

(4) Santorini, *loc. cit.*

(5) Petit, in the *Mém de Paris*, 1736, p. 7.—Sœmmerring, *loc. cit.*

(6) Sœmmerring, *loc. cit.* Several cases.

(7) Michælis, *loc. cit.*, p. 145.—Caldani, *loc. cit.*, p. 35.—Wenzel.

(8) Valsalva, in Morgagni, *Ep. anat.*, xiii. p. 115. obs. iii.

(9) Wenzel, *loc. cit.*, p. 125.

(10) Caldani, *Opusc. anat.*, p. 37. tab. ii. fig. 4. The simple maceration in water, or immersion in sulphuric acid and vinegar, gave no result; but this is not the case with nitric acid after the neurilemma was removed. Caldani has observed, eight times in this manner, that the external nervous fibres went directly to the eye of the same side, and the internal to that of the opposite side, that consequently these latter intercrossed, and that even the fasciculi visibly divided into several branches.

2d. By those pathological cases where one eye being destroyed and its nerve affected, the external fibres of the diseased nerve and of the healthy nerve, remained each on their side before and behind the decussation, while the internal fibres of the healthy eye passed through it to go to the opposite side, where they formed the internal fibres of the nerve of this side, and the internal fibres of the diseased nerve also passed to the healthy side, although less evidently, at least in some cases.(1)

3d. By the cases, where after the disease of an eye and of its optic nerve, the decussation and the nerve of the same side behind it, were wasted.(2)

4th. By the cases of the loss of an eye with the affection of only one optic nerve before the decussation and of the opposite nerve, or of both, behind this point.(3) This fact really seems to favor the hypothesis of a partial decussation, since different physiologists think it cannot be explained otherwise, and more so, because in many cases where the two nerves were wasted behind the decussation, that of the healthy eye was found unusually large.(4)

When all these pathological facts are duly considered, we must admit that they do not prove positively either of the three opinions, inasmuch as the dissection of the healthy parts has not demonstrated the fact of the decussation. In fact, they may be explained satisfactorily by saying that the substance of the two nerves is so blended in the decussation, that these nerves do not partially or wholly cross, and still less are they placed one against the other, but they properly arise from this common substance formed by the union of the two *optic bands* (*tractus optici*), which opinion differs much from that of a partial decussation. The differences of the pathological phenomena, authorize the adoption of this hypothesis, as this alone explains them very well. We may then consider as accidental, that where the optic nerve is diseased to the decussation, the alteration is observed on the other side of this union, on the cord of the same side, on that of the opposite side, or on both at once. This intimate union of the two portions of the optic nerves between their origin and decussation, is rendered very probable by what we have remarked, and which had been seen before us by Morgagni,(5) Michaelis,(6) Bichat,(7) and Wenzel,(8) that when the optic nerve had wasted and had been gray for a long time

Wenzel has once found in a subject whose sight was not affected, some gray substance in the centre of the decussation; the internal fibres of the two nerves evidently passed through this substance to intercross (*loc. cit.*, p. 118).

(1) Wenzel, 113, 217.

(2) Walter, *Ueber die Einsaugung und die Durchkreuzung der Sehnerven*, Berlin, 1794, p. 97.

(3) Ackermann, *loc. cit.*—This has been seen in most cases.

(4) Morgagni, *Epist. anat.*, xviii. 40.—Michælis, *loc. cit.*, p. 145.—Wenzel, p. 125.

(5) *Epist. anat.*, xviii. 40.

(6) *Loc. cit.*, p. 146.

(7) *Anat. descript.*, vol. iii. p. 153.

(8) *Loc. cit.* p. 112.

either before or behind the decussation, the decussation itself and the portion of the nerve before or behind it, was not in the least abnormal, and when the contrary occurred, the portion separated by the decussation from that first affected by the disease, was always altered much less than this latter. This phenomenon certainly indicates a great difference and a marked distinction between the posterior part of the nerve, including the decussation and the anterior portion, and the more, as when the portion situated before or behind the decussation is diseased, it usually presents the same kind of alteration in all its extent.

The differences between the pathological phenomena, mentioned by us above, depend perhaps on primitive differences of structure. This conjecture seems much more probable, as the structure of the nervous system, notwithstanding its great regularity, nevertheless frequently presents, when attentively considered, very great anomalies. It is then possible, that as in other organs situated on the median line, the union is sometimes more, sometimes less intimate, sometimes there is merely a juxta-position, and that there are a series of successive states, the first link of which is the case described by Sœmmerring, in Nœthig, and the last, that mentioned by Vesalius, although Haller rejects this hypothesis.(1)

Finally, the texture of the optic nerve before or behind the decussation, according as the origin of the nerve or the eye are primitively affected, proves nothing in favor of either of these three opinions, since in some cases where the sense of vision was lost in both eyes at the same time, one of the nerves was much thinner than the other behind the decussation.(2)

Finally, according to our own observations, this partial decussation is very probable; some at least of the differences in the pathological phenomena may then be easily explained, since, when the inner part of the optic nerve is affected, that of the opposite side, and when the outer part is diseased, that portion of the same nerve behind the decussation presents marks of disease.

§ 1879. The two optic nerves separate on leaving the decussation, and pass through the optic foramina into the cavity of the orbits. Here they are situated between the recti muscles of the eye, curve and become convex outward. When near the eye they contract very much, pass through the sclerotica and also the choroid membrane, and terminate in the organ, expanding in the retina.

They are first covered with neurilemma before the decussation. This membrane has there more firmness than in the other nerves, and penetrates within them, forming distinct sheaths. The optic nerves differ from all others, not only because they reunite, but also because they are intimately enveloped in all their course by a fibrous sheath, which is continuous posteriorly with the periosteum of the orbit and dura-mater, anteriorly with the sclerotica.

(1) *El. phys.* book xvi. vol. v. p. 752.
(2) Wenzel, p. 115. obs. ii.

XII. OLFACTORY NERVE.

§ 1880. The *olfactory* nerve, the *first pair*, the *ethmoidal* nerve (*N. olfactorius*, s. *par primum*, the *caruncula* of the ancients, who considered the optic nerves as the first cerebral pair), is situated on the lower face of the hemispheres of the cerebrum, in a groove which is there seen, but a few lines from their inner edge. It goes a little obliquely from without inward, so that the cords of the two sides are separated anteriorly only by the *crista galli* process. In this course it advances on the body of the sphenoid bone and the cribriform plate of the ethmoid bone, covered by the pia-mater, which extends like a bridge from one edge of the groove in which it is situated, to the other. This groove, however, is much deeper than the thickness of the nerve, and like all the other anfractuosities of the cerebrum, the pia-mater exactly covers its surface in all parts.

The olfactory nerve arises by three medullary bands or roots, from the posterior and inner part of the anterior lobe of the cerebrum, where this latter unites to the posterior lobe. The external band is the narrowest and strongest. Convex posteriorly, concave anteriorly, its direction is from behind forward, from without inward, and from above downward in the fissure of Sylvius, at the union of the anterior lobe with the posterior, proceeds at first almost transversely, then descends nearly perpendicularly, and reunites with the internal root some distance from the posterior extremity of the lower face of the anterior lobe.

The middle root, the shortest, and which it is generally more correct to consider only as the internal portion of the external root, arises from the centre of the anterior perforated plate or even directly from this plate by some fibres of which the internal are concave inward and the external are straight. After proceeding from one to two lines, it unites to the external root and gives rise to a common trunk a line and a half large and very broad, the direction of which is oblique from behind forward and from without inward.

The internal root is from one to four lines long. It comes from the internal posterior extremity of the lower face of the anterior lobe, proceeds obliquely from above downward, from behind forward, and from within outward, and anastomoses with the common trunk of the others.

All these roots are so imbedded in the gray substance that we perceive only their internal faces, and we cannot demonstrate them in every part without separating them by art.

Very probably all the gray substance in which they are imbedded should be regarded as a portion of the cerebrum which is connected with the origin of the olfactory nerve. This portion is oblong. It is continuous outward with the union of the anterior and posterior lobes, backward with the anterior perforated or cribriform plate, forward at its outside and inside with two circumvolutions which bound the fis-

sure of the olfactory nerve. It is loose at its centre and forms the posterior wall of this fissure within which it projects.

The nerve enlarges much from behind forward, so that its anterior extremity is two or three times thicker than its origin.

It is prismatic, the base looks downward, the two lateral faces are turned inward and outward, and the upper angle is the most acute.

In its whole extent it is very evidently formed of gray and of white substance disposed in longitudinal fibres which proceed at the side of each other and interlace together. Its anterior and enlarged extremity called the *bulb of the olfactory* nerve (*bulbus n. olfactorii*), is that part where, proportionally speaking, we find the most of gray substance.

In all the rest of the course of the nerve this substance is particularly abundant in the inner side. On the outside it is seen near the lower face.

The lower face of the bulb is the only part of the olfactory nerve whence filaments arise. These filaments, each of which is surrounded by a small prolongation of the dura-mater, pass through the openings of the cribriform plate of the ethmoid bone, thus enter in the nasal fossa, and are mostly distributed in the mucous membrane which lines the septum and the turbinated bones. They are distinguished into *internal*, *middle*, and *external*. We shall mention the manner in which they are distributed when describing the organ of smell.(1)

CHAPTER III.

GANGLIONNARY NERVE.

§ 1881. The *ganglionnary* nerve, the *nervous system of the ganglions*, the *great sympathetic* nerve, the *intercostal*, the *trisplanchnic* nerve (*N. gangliosus*, s. *N. sympatheticus magnus*, s. *intercostalis maximus*, s. *vertebralis*, Lieutaud, s. *trisplanchnicus*, s. *systema vitæ antomaticæ vegetativæ*, Bichat, Gall),(1) differs so remarkably from all

(1) The olfactory nerve has been considered as the conductor of the sensations produced by odors. Magendie, however, refers this function to the fifth pair, which sends so many different twigs into the nose. He rests his opinion on the fact, that the destruction of the olfactory nerves, and even of the anterior cerebral nerves, is not attended with the loss of smell, which, however, is always the case when the two nerves of the fifth pair are divided (*Le nerf olfactif est-il l'organe de l'odorat?* in the *Journ. de phys. expérim.*, vol. iv. p. 69). If this opinion be confirmed, the ethmoid nerve does not differ in this respect from the hypoglossal. F. T.

(2) Consult. 1st. On this nerve in general: C. Bergen, *De nervo intercostali*, Erfort, 1731.— A. F. Walter, *Programma quo paris intercostalis et vagi corporis humani nervorum et ab utroque latere ejus obviorum anatomen exhibet*, Leipsic, 1733, 1735.—J. F. Huber, *De nervo intercostali, de nervo octavi et noni paris deque accessorio*, Cassel, 1744.—C. C. Schmidel, *De nervo intercostali*, Erlangen, 1754.—M. Girardi, *De nervo intercostali*, Florence, 1791.—A. Portal, *Description du nerf intercostal dans l'homme*; in the *Mém. de l'Institut*, vol. iv. Paris, an. xi. p. 151, 209,

the other nerves and is so opposed to the rest of the nervous system in several respects that it would be more proper not to place it in the same class with the encephalon, the spinal marrow and their nerves, but to consider it as a different but subordinate system.

§ 1882. This system is formed of numerous ganglions, varying in number and size not only in both sides of the same subject but also in different individuals, and of nervous twigs, some of which unite these ganglions in several different ways, while others are given off to enter the organs. It exists uninterruptedly on the two sides and the anterior face of the vertebral column, along the neck, chest, and abdomen, so that its two halves frequently anastomose on the median line; it extends from the base of the skull to the lower extremity of the trunk, and is distributed in the organs of vegetative life.

The ganglions of this nervous system divide in respect to their situation and mode of distribution into two classes which comprise, the first the *internal* or *central ganglions*, the second the *limiting ganglions*.

The *central* ganglions are principally situated in the abdomen, around and above the trunks of the large vessels near the principal organs, those which appear most independent in their functions. Several adjacent ganglions are united to each other by larger or shorter filaments, and thus form a plexus whence arise some nerves which go to the organs, also some filaments which anastomose with other similar plexuses. The *limiting* ganglions are situated on the two sides of the vertebral column in succession. They are fewer in the neck than in the chest and abdomen, and are generally found in the two latter sections of the trunk between each two vertebræ. They are situated behind the serous membranes of the thoracic and abdominal cavities, and anastomose by some longitudinal cords with each other and with the central ganglions by some oblong or transverse fibres, and with most of the nerves of the centre of the nervous system

in the *Anat. med.*, vol. iv.—Bock, *Ueber das Gangliensystem*; in *Abhandlung uber das fünfte Nervenpaar*, Meissen, 1817.—E. H. Weber, *Anatomia comparata nervi sympathetici*, Leipsic, 1817.—J. F. Lobstein, *De nervi sympathetici humani fabrica, usu et morbis*, Paris, 1823.—2d. On its origin: D. Iwanhoff, *De origine nervorum intercostalium*, Strasburg, 1780.—J. Munniks, *Observatio qua 'ad illustrandam artem medicam, ostenditur origo nervi intercostalis, ejusque commercium cum aliis nervis, ab ejus origine usque ad exitum e calvaria, cum autopsia, tum observatis medicis confirmata*; in his *Observ. var.*, Groningen, 1805, no. ii.—3d. On some of its parts: C. T. Ludwig, *De plexibus nervorum abdominalium atque nervo intercostali duplici observationes nonnullæ*, Leipsic, 1772.—H. A. Wrisberg, *Obs. anat. de nervis viscerum abdominalium partic. I; de ganglio plexuque semilunari*, Gottingen, 1780. G. Walter, *Tabulæ nervorum thoracis et abdominis*, Berlin, 1783.—H. A. Wrisberg, *De nervis visc. abdom.*, part ii., *de nervis systematis cœliaci. Sectio I; de nervis gastricis, quæ est observationum de ganglio plexuque semilunari continuatio*; in the *Sylloge comment.*, 1800, p. 551, 570.—H. A. Wrisberg, *Obs. anat. neurolog. de nervis viscer. abdom.*, part iii., *de nervis systematis cœliaci II; de nervis hepaticis et splenicis, quæ est observationum de ganglio plexuque semilunari continuatio II*, Gottingen, 1808.—4th. On its functions. Broussais, *Réflexions sur les fonctions du système nerveux en general, sur celles du grand sympathique en particulier, et sur quelques autres points de physiologie*; in the *Journ. univ. des sc. méd.*, vol. xii.

particularly with the anterior and posterior branches of all the spinal nerves by intermediate filaments.

Such is the most general view of the ganglionnary nerve which can be presented. The chain of the limiting ganglions and of the nervous cords which unite them have been generally and until lately considered as its trunk and its upper extremity as its origin, admitting that prolongations proceed outward from these two points to the nervous system of animal life, inward to the thoracic and abdominal viscera. But now it is admitted to be more proper to describe first its most internal part, and to conclude with the history of the ganglions which connect it with the nervous system of animal life, and the filaments which establish this communication.

1. CENTRAL PORTION.

§ 1883. The centre of the ganglionnary nerve is formed of several ganglionnary plexuses situated in the cavity of the abdomen, and of the nerves which proceed from them to the organs, and the limiting ganglions. These plexuses considered from above downward are as follow:

§ 1884. The *solar plexus*, the *semilunar ganglion*, the *suprarenal ganglion* and *median plexus* (*P. solaris*, Willis, s. *G.*, s. *P. semi-lunaris*, *abdominalis*, *transversus*, *communis*, *cerebrum abdominale*) deserves to be first studied, since from its size, the constancy of its ganglions whence all the abdominal plexuses emanate, and its direct connection with several of the limiting ganglions, it is the real centre of the nerve.

It is situated before the abdominal aorta behind the peritoneum between the two renal capsules, and it surrounds the trunk of the cœliac artery.

The ganglions which unite to form it vary in number and size. We however always find at least two ganglions, a right and a left, which when many exist are always the largest. They are almost semicircular, generally more than an inch long, about half an inch broad in several parts particularly in the centre, and several lines thick from before backward. Their convex edge is turned outward, their concave edge inward.

The right is generally much larger than the left, broader in proportion to its length, angular and rhomboidal. It is situated between the ascending vena-cava and the right pillar of the diaphhragm, and the right renal artery and the upper extremity of the right renal capsule.

The left, smaller, is proportionally larger and more semicircular; it is situated between the left pillar of the diaphragm, the pancreas, the splenic artery, and the left renal capsule.

Both are united by numerous nervous filaments which proceed transversely from the internal edge and the two extremities of one to the

corresponding points of the other. All or most of these filaments ramify more or less in their course and frequently anastomose.

We usually observe between the two principal ganglions, particularly between their lower extremities in the space between the cœliac and superior mesenteric arteries, two or three which are smaller: these anastomose with each other and with the two larger ones by intermediate filaments, and apparently belong sometimes to the right and sometimes to the left ganglion.

Sometimes the principal ganglions instead of being thicker and broader at their centre as is usual, are very narrow there, while they enlarge at their extremities. This arrangement is the first step towards a rare anomaly, where they divide from above downward in a variable number of enlargements which communicate by nervous filaments. The middle enlargements thus formed are generally the largest; but sometimes although more rarely they are smaller than the superior and inferior, which renders the arrangement of the nerve still more abnormal.

The ganglions in the first case are nearer each other than in this latter; in the latter case they are sometimes united in several nervous filaments interwoven like a plexus. Sometimes from three to eleven small subordinate ganglions form on the outside above and below one or both of the principal ganglions; from these arise filaments which go to the adjacent plexuses, and also those which assist to form the great splanchnic nerve. The principal ganglion of the same side is more or less enlarged, so that this formation leads still more directly to that where it is entirely divided into a considerable number of smaller ganglions which are nearly equal in size.

Of all these forms those where the central portion is most concentrated is evidently superior to the others: they present a very remarkable repetition of the development of the centre of the nervous system of animal life both in the fetus and in the whole series of animals.

The whole solar plexus is considerably large and extends longitudinally from the upper edge of the cœliac artery to below the renal arteries, and it is from one to two inches broad.

It generally divides like the cœliac artery into three principal parts.

Some nervous filaments proceed directly from its middle and upper part; they unite to other filaments of the left pneumo-gastric nerve, give rise to the *superior coronary plexus of the stomach, stomo-gastrique*, Ch. (*P. coronarius*, s. *ventriculi superior*, s. *minor*), which accompanies the superior coronary artery along the small curve of the stomach, extends to the left orifice of this viscus and anastomoses particularly on the posterior face of the stomach with the inferior coronary and the left hepatic plexus, with which it communicates by twigs.

The second and largest of these plexuses is termed the *hepatic plexus* (*P. hepaticus*). It descends from left to right. One portion attends the right inferior coronary artery along the great curve of the stomach, where it is distributed and is termed the *inferior coronary plexus* (*P. coronarius stomachicus inferior*): the other is larger and

joins the hepatic vessels with which it goes to the liver. It first attends the hepatic artery, but near the sinus of the vena-porta it divides into a *right* and a *left hepatic plexus.* The first is larger than the other, and is formed of from six to eight filaments. It enters into the right lobe of the liver and the left goes to its left lobe. Both anastomose with some filaments of the right pneumo-gastric nerve and also form at intervals small prominences in the substance of the liver. Before entering this gland they send some filaments to the pylorus, and also to theduodenal and pancreatic arteries.

Independent of these plexuses a smaller one is sometimes detached from the right semilunar ganglion, the filaments of which proceed from behind forward and from below upward in the small lobe of the liver.

The *splenic plexus* (*P. splenicus*) arises from the right lower part of the solar plexus and the left semilunar ganglion, the branches of which accompanying those of the splenic artery which they surround pass on the pancreas, send some filaments to this gland, and also to the large cul-de-sac of the stomach, where they form the *small inferior plexus of the stomach* (*P. ventriculi inferior et minor*), and then enter into the substance of the spleen with the branches of the splenic artery.

Some branches arise from the lower part of the semilunar ganglions of the solar, the hepatic and splenic plexuses, and unite to form the *superior mesenteric plexus* (*P. mesentericus superior*). This plexus accompanies the trunk and branches of the superior mesenteric artery: its filaments are distributed principally to the small and large intestine, and some enter the pancreas.

The upper part of the semilunar ganglions sends off on each side four or five considerable branches which are enlarged by some filaments from the superior mesenteric plexus, descend towards the renal arteries, and interlacing by five or six subordinate ganglions form the *renal plexus* (*P. renalis*) on each side, which give numerous ramifications to the renal capsules and to the kidneys.

This plexus communicates upward and outward with the inferior thoracic and the superior lumbar ganglions by twigs, of which the upper unite in larger branches which go separately to the limiting ganglions and the nervous cords by which these latter are united.

The same plexus is continuous below with the *spermatic plexus* (*P. spermaticus*), which descends along the spermatic vessels, anastomoses with the superior and inferior mesenteric plexuses, gives some filaments to the ureter, and extends in man to the testicle, in the female to the ovary.

Some branches arise below from the superior mesenteric plexus, descend before the abdominal aorta, and enter the *inferior mesenteric*, the *left colic plexus* (*P. mesentericus*, s. *mesaraicus inferior*, s. *medius*, Vieussens). This latter, which is smaller than the upper, embraces the inferior mesenteric artery. It contains but a few small ganglions near this artery.

On entering the pelvis it divides into two pairs, one the *proper inferior mesenteric plexus* attends the branches and twigs of the inferior mesenteric artery, and anastomoses with the lumbar ganglion and sometimes also with the anterior branches of some lumbar nerves.

The other has a direction outward and downward, is termed the *hypogastric plexus* (*P. hypogastricus*, s. *mesentericus inferior*, s. *tertius*, s. *posterior*), anastomoses with the lumbar and sacral portions of the terminal cord of the ganglionnary nerve like the sacral nerves, and attending the hypogastric vessels is distributed to the rectum and the bladder, and in the male to the prostate gland and vesiculæ seminales, in the female to the uterus and vagina. It also emerges from the pelvis with the external branches of the hypogastric artery.

II. LIMITING CORD AND ITS BRANCHES.

§ 1885. We have already mentioned generally the arrangement of the limiting cord which is situated on the two sides of the vertebral column and the skull. We describe it from above downward, and commence by the superior cervical ganglion which exists constantly.

A. SUPERIOR CERVICAL GANGLION.

§ 1886. The *superior cervical*, the *olivary* or *fusiform ganglion* (*G. cervicale supremum*, s. *olivare*, s. *fusiforme*), one of the largest of those of the ganglionnary nerve, is situated above and behind the angle of the lower jaw, behind the internal carotid artery before the transverse processes of the second and third cervical vertebræ and the rectus capitis major anticus muscle, on the inside of the pneumo-gastric and hypoglossal nerves. It is surrounded by a cellular sheath which envelops also the trunk of the pneumo-gastric nerve.

Its form and size vary much. It is almost always oblong, thinner below than above, terminates however also in a point at its upper and fusiform extremity. Sometimes it tends to divide into several ganglions situated successively from above downward. The first degree of this anomaly is a contraction in its centre. Next comes the formation of an upper or lower appendage; we then observe contractions in two or three points.(1) It does not constantly extend entirely to the carotid canal. Below it usually descends to the third, sometimes however to the sixth cervical vertebra. Generally it is an inch and a half long and its greatest breadth is three lines; its length however varies from some lines to four inches, but its breadth and thickness are always inversely as its length.

It sends off numerous branches upward, outward, inward, forward, and downward.

(1) Lobstein has figured (tab. v. fig. 3) a superior cervical ganglion which he has found double.

I. UPPER BRANCHES.

1. The superior branch is sometimes although very rarely double, leaves the upper extremity of the ganglion, enters into the carotid canal, and establishes a communication between the ganglionnary nerve and the portion of the nervous system of animal life contained in the skull. It is situated behind the internal carotid artery towards the lower curve of which it usually divides into two nearly equal branches which separate at an acute angle and ascend in the canal before the carotid artery, one being more external than the other.

Opinions vary both in regard to their mode of anastomosis and the number of the portions of the nervous system contained within the skull, with which the ganglionnary nerve communicates by these filaments; these differences in opinion depend partly on the difficulty of dissecting such delicate parts, partly on the varieties in their arrangement.

The most ancient opinion was that the ganglionnary nerve anastomosed only with the fifth pair.(1)

At a later period it was asserted to anastomose only with the external motor nerve.(2)

Then it was admitted to be connected with both.(3)

Anatomists vary also as to the point where the ganglionnary nerve communicates with the two encephalic nerves; the differences in opinions are but slight and trivial in regard to the external motor nerve; but they are great in regard to the fifth pair, for it anastomoses according to some with the trunk of this nerve,(4) according to others with one(5) or more(6) or even with all of its branches. Some think they communicate directly,(7) others indirectly and by ganglions:(8) the descriptions also of the anastomosis with the sixth pair vary in this last respect.

§ 1887. The ganglionnary nerve always anastomoses with the sixth pair in the carotid canal by a considerable branch coming from the superior cervical ganglion, which ascends along the internal carotid artery first on the outside and then on its anterior face.

(4) Galen, *De nervorum origine*; in *Op. omn.*, Venice, Vol. ii. p. 54.—The Arabians and the first Italian anatomists have adopted his opinion. Rau and Valsalva assert that they have sometimes observed this arrangement since. (Morgagni, *Ep. an.* xvi. p. 330.)

(2) Eustachius, tab. xviii. fig. 2.—Morgagni, *Adv. anat.*, vol. vi. p. 30.—Santorini, *Obs. anat.*, c. iii., p. 67.

(3) Meckel.

(4) Schmidel, Munniks, Bock.

(5) Most authors.

(6) Laumonier.

(7) Most authors who have written on this subject, and on neurology in general.

(8) Petit, *loc. cit.*—Schmidel, *loc. cit.*—Laumonier, in Bacher, *Journ. de méd.*, vol. xciii., March, 1793, p. 259.—Munniks, *Obs. var.*—Cloquet, *Tr. d'anat.*, vol. ii., p. 686.

This branch generally unites to the external motor nerve by a single twig which meets it and is detached at an acute angle from the external and inferior part of the sixth pair during its passage through the cavernous sinus.

This twig is not unfrequently double and sometimes the recurrent filament of the external motor nerve bifurcates soon after arising.

Sometimes also the anastomosing branch of the ganglionnary nerve within the sixth pair is double, in which case one proceeds on the outside the other on the inside of the internal carotid artery.

We frequently and even perhaps always find at the upper part of the carotid canal or in the cavernous sinus, instead of a direct anastomosis, a ganglion situated on the outside of the internal carotid artery called the *cavernous ganglion* (*G. cavernosum*). Three or more filaments proceed from the summit of this ganglion to the nerve of the sixth pair.(1)

The anastomosis with the trifacial nerve is always by a filament which goes to the recurrent twig of the second branch of the fifth pair or the vidian nerve. This filament is distributed partly in the carotid artery, partly also emerges from the carotid canal, passes through the dura-mater and enters the pterygoid canal where it unites with the recurrent twig.

Thus the branch from the upper extremity of the upper cervical ganglion usually divides into these two filaments, one of which goes to the external motor, the other to the trifacial nerve.

This bifurcation generally takes place within the carotid canal, seldom below and never above it.

Sometimes but rarely also the upper extremity of the superior cervical ganglion gives origin to two superior branches, which go one to the external motor the other to the vidian nerve.

When this arrangement exists the two anastomotic filaments and the vidian nerve communicate with the external motor nerve. Sometimes also this triple anastomosis does not exist.

An analogous case is where either the anastomosing filament which goes to the external motor nerve or that which proceeds to the trifacial or both divide into several filaments, all of which unite in a common trunk to go to the superior cervical ganglion.

§ 1888. This is the only anastomosis admitted by most authors between the ganglionnary and the trifacial nerves. In fact it is often the only one which can be demonstrated. But the great sympathetic nerve also unites by its upper extremity in another manner, at least sometimes, with the trifacial nerve.

Many anatomists, and Portal among others, positively reject this other anastomosis; but many observations favor its existence.

In fact according to Schmidel and Munniks, several filaments come from the ganglionnary plexus of the fifth pair and go to the carotid

(1) Laumonier, *loc. cit.*—Munniks, *loc. cit.*

canal, where they unite with other filaments of the external motor nerve and form a ganglion.

Others however whose opinions are like the preceding, assert that beside those filaments mentioned, or even if they do not exist, we find a smaller twig coming from the first branch of the fifth pair; and this unites sooner or later either with the anastomosing filament of the sixth pair, as Petit,(1) Schmidel,(2) and Coopmanns(3) assert, or with the cavernous ganglion.(4)

Laumonier, on the contrary, has found coming from the cavernous ganglion, the two filaments which anastomose with the sixth pair and the vidian nerve, and also a third which went to the second branch of the fifth pair, and a fourth to the fourth branch of this same pair.(5) Bock(6) asserts that ten filaments go to the anterior extremity of the trunk of the fifth pair, particularly towards the portion which corresponds to the first branch.

All these assertions, however agree, in this, that besides the filament which anastomoses with the vidian nerve, one or more anastomoses exist nearer the origin of the fifth pair with one or several of its three principal branches, or with its trunk: these anastomoses take place by a ganglion, and from this arises the filament of communication with the superior cervical ganglion.(7)

We also sometimes find a more indirect anastomosis between the upper extremity of the ganglionnary nerve and the third pair of cerebral nerves, the latter anastomosing with the sixth and fifth in the place where they give filaments, which communicate with the great sympathetic nerve.(8)

According to Fontana(9) and Ribes,(10) whose correctness we have partially attested, the ganglionnary nerve penetrates still farther upward and forward, for it sends some filaments from the carotid canal to the pituitary gland,(11) or to the infundibulum,(12) and also a fasciculus which accompanies the ophthalmic artery, forms a plexus around the different branches of this vessel, not excepting the central artery of the retina, and anastomoses by a filament with the lenticular ganglion,

(1) *Loc. cit.*, p. 4.
(2) *Loc. cit.*, p. 16, 21.
(3) *Loc. cit.*, p. 219.
(4) Cloquet, *loc. cit.*, p. 687.
(5) *Loc. cit.*, p. 259.
(6) *Vom fünften Nerven*, p. 3.
(7) Lobstein does not admit all these anastomoses; he has seen some transparent and gelatinous filaments which united the ramifications of the great sympathetic nerve with the common motor and other nerves; but by examining them with the microscope, he has not found in them the characters of nervous organs. He regards them as cellular tissue extended in filaments. F. T.
(8) Munniks, *loc. cit.*, p. 25.
(9) In Girardi, *loc. cit.*, p. 25. As Carus (*Anatomie und Physiologie des Nervensystems*, p. 185) has also observed in several reptiles.
(10) Ribes, *Rech. anat. et phys. sur quelques parties de l'œil*; in the *Mém. de la soc. méd. d'émul.*, vol. vii. p. 97.
(11) Fontana, *loc. cit.*, p. 56, 57.
(12) Cloquet, *loc. cit.*

consequently with the first principal branch of the fifth, and with the third pair.(1). And likewise as there exists also between the lenticular ganglion, the cavernous sinus, and all the ganglionnary system, a constant relation,(2) similar to that between the two ganglions, we consider this small filament with the ciliary nerves which come from it, as making part of the great sympathetic nerve, which supposition seems to us very probable.

II. EXTERNAL BRANCHES.

The external branches are from one to four in number, pass above the rectus capitis major anticus muscle, to go and meet the first and second cervical nerve. When there is only one, it is larger, and soon divides into as many branches as generally exist, comes sometimes from the upper, and sometimes from the centre of the superior cervical ganglion. The upper two arise from the upper extremity of this same ganglion, directly at the side of each other, and anastomose with the anastomotic plexus of the first and second cervical nerves. The third communicates with that of the third and fourth cervical pairs. The fourth which arises more frequently from the twig of communication between the first and second cervical ganglions, anastomoses on one side by several filaments with the anastomotic plexus of the third and fourth cervical nerves, and is distributed in the rectus capitis major anticus and the scalenus anticus muscle.

III. INTERNAL BRANCHES.

The internal branches are much smaller and less constant in respect to number, and are distributed to the longus colli, the rectus capitis major anticus muscle, the pharynx and the larynx.

IV. ANTERIOR BRANCHES.

The anterior branches are the largest and most numerous. They are distinguished by their reddish tint and their softness, and hence are termed *soft* nerves (*N. molles*). The superior are shorter than the others, proceed from below upward, and anastomose with the hypoglossal, the pneumo-gastric, and the facial nerves, just after they emerge from the skull. The middle and inferior are larger, go forward and downward, envelop the primitive carotid arteries to their origin, anastomose in this course with some branches of the pneumo-gastric nerve, and surround also, together with the facial and pneumo-gastric nerves, the branches of the external and internal carotid arteries, to the carotid canal. The latter not unfrequently come from a distinct small ganglion.

(1) Ribes.—Cloquet.—Bock.
(2) Ribes.—Cloquet.—Bock.

The largest anterior branch is the *superior* or *superficial cardiac* nerve (*N. cardiacus superior*, s. *superficialis*), which arises by from four to six filaments from the internal anterior part of the cervical ganglion, sometimes also partially or wholly from the upper extremity of the cord which joins this ganglion to the following. The minute nerve formed by the union of these filaments, descends on the outside of the primitive carotid artery, covered by the cord of communication of the great sympathetic nerve, gives off at about its centre some filaments which surround the inferior thyroid artery, anastomoses with one or two twigs of the pneumo-gastric nerve, communicates also with the descending branch of the hypoglossal nerve, gives ramifications to the pharynx, the esophagus, the sterno-hyoideus and sterno-thyroideus muscles, and usually terminates partly by anastomosing with some ramuscules of the recurrent branch of the pneumo-gastric nerve, and partly sends retrograde filaments to the thyroid gland. It more rarely descends to the arch of the aorta, where it unites to the middle cardiac nerve; but it never extends to the heart, so that it does not deserve the term applied to it.

That of the left side commonly extends farther than that of the right.

V. INFERIOR BRANCH.

The inferior branch establishes the communication between the superior and the middle, or the inferior cervical ganglion, and is generally considered as the continuation of the trunk. It varies in size and firmness. It is generally thinnest in its centre, and is always larger than the superior cardiac nerve which is situated before and on the inside of it. It constantly arises from the lower extremity of the superior cervical ganglion, with which it is less directly continuous, the larger it is and the smaller the ganglion. Its length depends on that of the superior ganglion, and on the presence or absence of the middle one. It always exists. It is situated before the rectus capitis major anticus and the longus colli muscles, near the inner edge of this latter, first behind the internal carotid artery, then behind the primitive carotid, between the internal jugular vein and the pneumo-gastric nerve.

It is most generally single. Very rarely it is divided at its lower part into two twigs, which embrace the inferior thyroid artery, and which usually enter, one the middle cervical ganglion, the other the inferior cervical ganglion.

This branch anastomoses by some external filaments with the accessory and several cervical nerves, more frequently with the superior than the inferior, sometimes even with the eighth. These differences and those in the length of the cord, depend on those in the size of the superior cervical ganglion, and also on the presence or absence of the middle ganglion. The anastomosing branches generally unite in some larger branches before coming to the trunk of the ganglionnary nerve.

From this branch arise some filaments which contribute to form the superficial cardiac nerves. It gives some also which unite to others coming from the superior cervical ganglion, sometimes arise only from the superficial cardiac nerves, and go almost transversely inward, and are distributed, the superior particularly, in the constrictor muscles of the pharynx, the inferior in the thyroid gland, the muscles, and the mucous membrane of the larynx. These filaments frequently anastomose with each other or with some ramifications of the pneumo-gastric and glosso-pharyngeal nerve.

B. MIDDLE CERVICAL GANGLION.

1889. The *middle cervical* or *thyroid* ganglion (*G. cervicale medium*, s. *thyroideum*) is situated at the origin of the inferior thyroid artery, between the fifth and sixth, or between the sixth and seventh cervical vertebræ, directly before the longus colli muscle, behind the primitive carotid artery and the pneumo-gastric nerve. It is not so constant as the superior; it however exists more frequently than it is absent, and in the proportion of 3 : 1, judging from our dissections; it is sometimes extremely small, and sometimes deficient. It is never oblong, but always broad and slightly flat. When deficient, we sometimes, but not always, find in its place two inferior cervical ganglions, in which case consequently, it is only situated lower than usual. Sometimes, but much more rarely, it is double, that is, it is divided into two small ganglions, a superior and an inferior, the former of which is then situated higher than the common single ganglion.

Its branches go upward, outward, inward, forward, and downward.

The *superior* unites it to the superior cervical ganglion, which we have already described.

The *external* are sometimes reduced in number to one, anastomose with one or more of the inferior cervical pairs, especially from the fourth to the sixth.

The *internal* accompany the inferior thyroid artery, on which they give rise to the *thyroid* plexus (*Pl. thyroideus*), extend to the thyroid gland, and go to join and enlarge the recurrent laryngœal nerve.

The *anterior* form the *middle or deep cardiac* nerve, the *great cardiac* nerve (*N. cardiacus medius*, s. *magnus*, s. *profundus*), which is the largest. Five or six filaments unite near the ganglion, first into two or three fasciculi, then in a trunk which descends obliquely from without inward, first along the primitive carotid artery, then before the subclavian, anastomoses in its course by several filaments with the trunk of the pneumo-gastric nerve, and with its recurrent branch, and unites with the inferior cardiac nerve to form the cardiac plexus.

The middle cardiac nerve differs on the right and left sides.

That of the right side, after passing before the subclavian artery, descends along the trunk of the innominata, unites at its bifurcation by a small ganglion with one or two twigs of the pneumo-gastric nerve,

and then passes between the arch of the aorta and the bifurcation of the trachea.

That of the left side arises by several filaments from the middle cervical ganglion, and from the inferior ganglion by one or two filaments which are larger than the preceding. The two ganglions then unite in this place, while on the right side they remain separate. The two roots unite some distance from the origin of the subclavian artery. The trunk passes behind the arch of the aorta, there unites to some filaments of the pneumo-gastric nerve, and anastomoses with that of the right side, and likewise with the two inferior cardiac nerves, to form the cardiac plexus.

The inferior branches are very minute, shorter than the rest, and five or six in number. They descend on the right side before and behind the subclavian artery, on the left side before and behind the trunk of the aorta, and anastomose with the superior ascending branches of the inferior cervical ganglion.

Sometimes the anterior of these branches are deficient, and the posterior also are united in a short common trunk, which establishes a direct connection between the two cervical ganglions.

C. INFERIOR CERVICAL GANGLION.

§ 1890. The *inferior cervical* ganglion (*G. cervicale inferius*) is much more constant than the central, and is generally flat, rarely rounded and oblong, often very irregular, and sometimes double. It is situated before the transverse process of the seventh cervical vertebra and the neck of the first rib, but sometimes descends to the second rib.

Its *superior* branches anastomose with the inferior of the middle ganglion. One which is rather large, enters the vertebral canal, where it entwines around the vertebral artery, sends some filaments to the intertransversarii muscles, and terminates at the third or second cervical vertebra.

Sometimes this branch arises only from the filaments which anastomose with the brachial plexus.

The *external* are smaller, but numerous, surround the subclavian artery, and give ramifications to the muscles of the neck, and anastomose with the two or three inferior cervical nerves, and also with the first dorsal, sometimes even but more rarely with the second thoracic pair, when the inferior cervical ganglion is much developed.

The *internal* terminate principally in the longus colli muscle and the pulmonary plexus.

The *anterior* form the *inferior cardiac* nerve (*N. cardiacus inferior*. s. *tertius*, s. *parvus*), which generally exists only on the right side, while on the left it is only indicated by the inferior root of the great cardiac nerve. These branches frequently interlace before uniting in a single trunk. The latter descends first behind the subclavian artery, then before the innominata and the arch of the aorta, anastomoses often

with the pneumogastric nerve, gives some filaments to the vessels situated near its course, and goes to the left between the aorta and the pulmonary artery, and terminates in the anterior cardiac plexus.

CARDIAC PLEXUS.

§ 1891. The *cardiac plexus* (*Pl. cardiacus*) is formed principally by the middle cardiac nerves. It is situated between the arch of the aorta and the bifurcation of the trachea. It extends from the division of the pulmonary artery to the origin of the innominata.

Its anterior filaments go principally to the anterior wall of the aorta, and the posterior to the pulmonary plexus. The inferior are more numerous, and go almost exclusively to the heart, where they form the two *coronary plexuses* (*Pl. coronarii*), in which also terminate some filaments of the inferior, and more generally of the superior cardiac nerve.

The *posterior coronary* plexus is much larger than the anterior; it goes to the base of the heart, descending on the left pulmonary artery. It is distributed to the lower and posterior part of the left ventricle, along the posterior coronary artery and its branches.

The *anterior* follows the course of the left *inferior* cardiac nerve, in its whole extent, passes between the aorta and the pulmonary artery, and after anastomosing at its upper part with the posterior, attends the anterior coronary artery and its ramifications, on the upper face of the heart and the right auricle, where it frequently anastomoses with the posterior, along the posterior edge of the organ. Some smaller twigs of this plexus proceed on the left pulmonary artery, and go to the pulmonary plexus of the left side.

The two plexuses frequently anastomose with some branches of the pneumo-gastric nerve.

They are, however, mostly formed by the ganglionnary nerve.

After leaving the lower part of the neck, the ganglions of the great sympathetic nerve are more numerous.

D. THORACIC GANGLIONS.

§ 1892. We find in the chest between the transverse processes of each two vertebræ, and on each side, a ganglion called the *thoracic* (*Gl. thoracicum*). These ganglions are generally slightly rounded, elongated, triangular, and fusiform. They are situated more on the outside than the cervical. The first counting from above downward (*G. thoracicum supremum*) is the largest of all the limiting ganglions except the superior cervical. Sometimes it is blended with the second; this, however, is rare, and even when it appears, generally exists on the outside. The middle ganglions are often a little smaller than the superior and the inferior.

All these ganglions are united to each other by one very strong filament, rarely by two.

The superior is almost constantly attached to the inferior cervical nerve by two filaments, the anterior, of which not unfrequently divides in turn into two smaller filaments. Each thoracic ganglion anastomoses on the outside by two filaments, with its corresponding thoracic nerve. Internally, the superior gives off branches, some of which go to the lower part of the longus colli muscle, others to the cardiac plexus, several to the pulmonary plexus, which, however, is principally formed by the pneumo-gastric nerve ; finally, some proceed to the aorta.

I. SPLANCHNIC NERVE.

§ 1893. From the inferior thoracic ganglions, and from their filaments of union, generally from the sixth or the seventh to the eleventh, arise cords, the upper of which are usually the largest ; they vary in number from three to seven, and are very rarely the same on both sides of the body ; they unite at an acute angle near the diaphragm, to form the *splanchnic* nerve, *grand surrenal*, Ch. (*N. splanchnicus*). This nerve descends behind the pleura, and generally goes from the chest into the abdomen, between the inner and middle prolongations of the pillar of the diaphragm, sometimes also through the aortic opening. It anastomoses in the abdomen principally with the semilunar ganglion of its side, sometimes directly, sometimes indirectly, by some small ganglions. It then forms the principle mode of union between the central portion of the ganglionnary nerve and the limiting ganglions. Not unfrequently some of the roots by which it arises, particularly the inferior, go separately to the semilunar ganglion, and some of them often anastomose, not with this ganglion, but with some filaments of the solar, the hepatic, the splenic, and the two renal plexuses.

II. SMALL SPLANCHNIC NERVE.

§ 1894. Two or three inferior branches, which, however, remain distinct, sometimes unite on the right side more frequently than on the left, in a small special trunk, called the small *splanchnic* nerve, *petit surrenal*, Ch. (*N. splanchnicus minor.*) This trunk passes through the pillar of the diaphragm below the preceding. It is enlarged by some filaments from the superior lumbar ganglions, and goes principally into the renal plexus, which is often in great part formed by it.

E. ABDOMINAL GANGLIONS.

§ 1895. The cord by which the limiting ganglions unite is always very small below the origin of the splanchnic nerve. Sometimes it is entirely deficient in some points, so that the trunk of the great sympa-

thetic nerve is there interrupted(1) and the limiting ganglions form one and the same series with the abdominal ganglions and plexuses only by intermediate connections. When this series comes on the lumbar vertebræ it goes forward. We there see ganglions which are much smaller, more remote from each other, and less constant in their situation than those hitherto examined. The upper is always larger than the others, which gradually diminish from above downward and often do not exist, or at least are almost invisible.

The upper pelvic ganglions of the limiting cord are a little larger than the inferior lumbar, and form a series which converges from above downward. There are usually four or five, the lowest of which is situated forward between the sacrum and the coccyx, and anastomoses with the corresponding ganglion of the opposite side by a shortened thin filament which is convex downward.

The lumbar and pelvic ganglions are united by some filaments which differ from those existing between the others in their length and also in their number and size; for there are usually three or four between each two ganglions, which are much smaller than those between the superior ganglions.

Their *external* branches proceed to meet the lumbar and sacral nerves, and anastomose with their anterior branches near the intervertebral and sacral foramina.

Those of the superior lumbar ganglions have a direction oblique from below upward.

The middle are transverse, and the superior oblique from above downward. The latter are very long, the first very short. Some which are smaller go upward to the psoas muscle, downward to the pyramidalis and to the levator ani muscles.

The lumbar ganglions give off some *internal* branches which go to the anterior face of the aorta, and contribute to form the *aortic plexus* which comes from the superior mesenteric plexus. Some of the sacral ganglions anastomose together before the sacrum; others terminate in the hypogastric plexus.

The series of limiting ganglions terminates below in some filaments which radiate from the last of them, and which are distributed in the lower and posterior part of the rectum.

§ 1896. Our mode of describing the ganglionnary nerve differs from that hitherto adopted even by those anatomists who consider it as directly opposed to the rest of the system, for they generally commence by that part which descends along the vertebral column, by the external ganglionnary cord, and terminate with the central portion.

(1) This has been seen twice by Haller (*Elem. phys.*, vol. iv. p. 261). Bichat has also made this remark (*Rech. phys. sur la vie et la mort*, p. 82), and uses this as the principal argument in favor of his opinion, that the sympathetic nerve does not form a continuous trunk from the head to the pelvis. Wrisberg (*Obs. anat. de ganglio plexuque semilunari*, § 19, in the *Comm. Gœtting*, 1779, vol. ii. p. 102) has admitted this arrangement to be an anomaly, and Weber (*Anat. comp. nervi sympath.*, p. 122 regards this observation as doubtful.

Our course will at first view be more surprising, because we have several times mentioned that there is no manifest contrariety between the two nervous systems.

In fact the ganglionnary nerve is only the highest development of a form which has passed through several gradations. We may consider the diaphragmatic nerve as the first of these; this arises from several cervical pairs, and passes some distance to go to a voluntary muscle, the diaphragm, the principal agent in respiration. This formation is still more developed in the four posterior cerebral nerves, particularly in the pneumo-gastric, which forms plexiform anastomoses with the superior cervical nerves, descends along the neck, is distributed to the organs of respiration, and descends to the stomach in the abdominal cavity. The whole course of this nerve favors our analogies still more, inasmuch as it forms numerous plexuses whence branches proceed to the organs.

The ganglionnary nerve, if we except some filaments which arise perhaps from the pituitary gland, does not commence directly at the centre of the nervous system, but from several of the cerebral and from all the spinal nerves. It descends lower than the pneumo-gastric nerves, gives some filaments to all those organs of vegetative life which receive none from this latter, and frequently anastomoses with the two preceding. The plexiform and ganglionnary structure is more evident in it than in any other nerve, so that even the inner part of its expansion exceeds the outer; and hence from its form, situation, and connections with the encephalon and spinal marrow, it may be regarded as the trunk of the nerve, as is generally admitted, and thus the inner part is considered the central portion.

These are our reasons for departing from the common course, although the anatomical and the physiological relations of the ganglionnary nerve prove that it is dependent on the centre of the nervous system, being connected with it by its outer part.

CHAPTER IV.

DIFFERENCES PRESENTED BY THE NERVES DURING THEIR DEVELOPMENT.

§ 1897. The differences presented by the nerves during their development have been but slightly studied, and we have but few observations which refer to them. Not having had sufficient opportunities of obtaining well preserved human fetuses, we cannot add as many remarks as are desirable to those already existing.

We may state on this subject the following corollaries:

1st. All the nerves are not developed with equal rapidity in respect to color, texture, and consistence. The spinal generally increase

faster than the cerebral nerves. We have found them perfectly white and evidently fibrous in the fetus of six months, while the cerebral nerves were gray. The fibrous texture and color are developed latest in the optic nerves. At six months it is much larger than the other encephalic nerves, and even at the ninth month of pregnancy it is still as gray as the rest of the cortical substance, is very soft, and presents no appearance of fibres. We have not yet been able to determine if it whitens before birth; it however experiences this change early, for in two children one month old we have found it perfectly white in all its course, except most of the portion between the decussation and the eye; the latter was entirely white before the decussation, gray on the outside and white on the inside in the centre; finally totally gray forward.

We may conclude from these facts that the nerves complete their development from within outward and from behind forward. This proposition applies both to the different nerves and to the same nerves in different parts of the body. It is then very curious that the olfactory nerve which is the most anterior remains almost entirely gray during life, and constantly preserves this tint in its whole anterior part. This law seems to be general, for we have since met with it in fetuses of the hog and cat.

We have also found the great root of the trifacial nerve entirely gray in the fetus of eight months.

2d. The following remarks are applicable to the other differences presented by the nerves:

Among the spinal nerves we have found in a great many fetuses the crural nerve divided on emerging from the pelvis into its tibial and peroneal branches, which were the more distinct the younger the fetus.

Before the end of the fifth month of pregnancy they were not united so intimately as they are at an advanced age; hence this arrangement, which is abnormal in the adult, is normal during the early periods of existence.(1) We have not been able as yet to observe any difference in the other spinal nerves.

The trifacial nerve differs from what it is in the adult:

1. In the number of its cords, which are at first fewer. In the fetus of eight months there are only eighteen in the large root, while there are from twenty-eight to thirty in a child when born.(2)

2. The texture of its ganglionnary plexus is less fibrous. We have found structure of this plexus was homogeneous at the sixth month of pregnancy.

These two peculiarities may be referred to the same principle, the imperfect development of the nervous tissue.

(1) We have already said that this arrangement is curious as analogous with the mammalia, but did not intend to assert that it is common to all these animals.

(2) Vesling, *Obs. anat.*, no. viii.—Sœmmerring, *De basi encephali*, § 60.—Niemeyer, in Reil, *Archiv. für die Physiologie*, vol. xi., p. 54.

The olfactory nerve is at first proportionally much larger; at the same time it is rounded, thicker, and shorter.

Until the sixth month there is within it a cavity which communicates with the lateral ventricles of the cerebrum.

These are two remarkable analogies with the mammalia.

In the full grown fetus its external root is evidently medullary. We perceive also some medullary striæ on the lower face of the nerve, but there is no trace of the medullary band which represents its internal root.

In the early periods of fetal existence the great sympathetic nerve is more developed in proportion to the body than almost any other part of the nervous system. It is very remarkable that the large limiting ganglions are so near each other, particularly in the chest, that they form an uninterrupted series. The splanchnic nerve is also proportionally much thicker than in the adult.

At about the middle of fetal existence this nerve has diminished much, and then presents very nearly the proportions which continue during life.(1)

CHAPTER V.

PARALLEL BETWEEN THE DIFFERENT NERVES.

I. BETWEEN THE SPINAL AND THE ENCEPHALIC NERVES.

§ 1898. The spinal and encephalic nerves are generally strictly opposed to each other, and are distinguished by characters mentioned previously (§ 170); but the differences between them are not so distinct as is asserted. First those which truly exist do not prevent us from considering the encephalic nerves in the condition of spinal nerves, and from demonstrating that they are only modifications of the latter, and from investigating the cause of these modifications.

All the encephalic nerves are portions of spinal nerves which are not united in a single trunk like the latter, but are developed as so many separate nerves. This modification of the primitive type depends on the development of the centre of the nervous system within the skull and on that of the skull itself, which mechanically separates the different groups of the roots of the nerves at their origin and in their course.

It also depends on special organs, those of the senses, which are developed in the skull, the roots of which are formed by the nerves that go to them, and which are perfect in the direct ratio of the development of their special nerves. Comparative anatomy demonstrates, at least

(1) Lobstein has given a history of the evolution of the ganglionnary nerve in the fetus, and the modifications it experiences as age advances (*loc. cit.*, p. 47-56.)

in regard to several organs of the senses, that new nerves are not formed for them,(1) but only that single branches arising from a special part of the encephalon become trunks. In fact we see several nerves, especially among those of the organs of the senses, which form separate trunks in superior animals, are only subordinate branches in the inferior animals. This is the case particularly with the trifacial nerve; and this is much more evident the more inferior the animal.

This development of portions of nerves which raises them to the rank of distinct nerves is gradually increased from the posterior to the anterior extremity of the cerebrum. It is manifested in the posterior pairs only by the want of union between the anterior and posterior roots; but the anterior roots seem to be formed from the fact that single fasciculi appear to be the proper nerves.

The nervous system then follows precisely the same type as the other systems, particularly the osseous; for the bones of the skull are more similar to the vertebræ the more posteriorly they are situated, and the dissimilarity between them and the vertebræ which gradually increases from behind forward, depends principally upon the fact that simple portions of the vertebræ have become sufficiently developed to be considered distinct pieces of bone.

In this view of the subject, we should consider the last four cerebral pairs, the accessory, the pneumo-gastric, the glosso-pharyngeal, and the hypoglossal nerves, as so many sections of one and the same nerve, the posterior of which is formed by the first three nerves, and the anterior by the fourth. In fact, the accessory, the pneumo-gastric, and the glosso-pharyngeal nerves, arise by an uninterrupted series from the posterior cord of the spinal marrow, and emerge from the skull through the same opening. They thus form in the skull, trunks, the external parts of which are separate from each other, and generally pass through the dura-mater in different points. But this is far from being the case with the accessory nerve, and even when it is, the accessory is adapted to the pneumo-gastric nerve so intimately, that they form a single trunk. Beside, after the two nerves separate, the inner branch of the accessory nerve again unites with the eighth pair, and continues with it. The glosso-pharyngeal nerve also anastomoses by one filament even within the cranium, with the pneumo-gastric nerve, and after leaving the skull, they communicate by several other filaments. It is curious that the accessory and pneumo-gastric nerves on one side, the glosso-pharyngeal nerve on the other, and just before where it unites with the two preceeding, form ganglions near the place where they emerge from the skull, exactly as do the posterior

(1) See on this subject the important memoir of Treviranus, in which he proves that the nerves of the fifth pair take the place of those of very important senses in some animals, and that there is in these animals some organs of sense very different from those of man, the nerves of which are the branches of the fifth pair (*Sur les nerfs de la cinquième paire, considérés comme organes ou conducteurs de sensations*; in the *Journ. complém. des sc. méd.*, vol. xv. p. 207). His observations have been confirmed since by Magendie. F. T.

roots of the spinal nerves; nor ought we to omit mentioning that the posterior root of the superior cervical nerve often joins the accessory, which then assumes the character of the posterior root, which character is also expressed very distinctly by its situation behind the ligamentum denticulatum.

The glosso-pharyngeal nerve, the anterior root of this pair of nerves, arises from the anterior cord of the medulla oblongata, like the other anterior roots of the spinal nerves, and as its origin is situated more inward and forward, it also emerges from the skull through an opening situated more inward and forward. In fact, it leaves the skull through a special opening in the occipital bone, rather distant from that through which the other three pass. But this difference from the spinal nerves depend on the two causes mentioned above, and we see in it only a greater development of the arrangement of the anterior and posterior roots of the spinal nerves which pass through distinct openings in the dura-mater before uniting; finally, the glosso-pharyngeal nerve just after leaving the skull, is adapted directly to the trunk of the pneumo-gastric nerve, anastomoses with it by some filaments, particularly below its ganglion, and goes forward, while the eighth pair, united with the other two, is distributed principally below and backward. We ought not to forget that this nerve never forms the ganglion alone, and rarely or never communicates with the ganglion of the three posterior nerves.

The fasciculi of this nerve, like those of the first three, frequently emerge from the dura-mater, and sometimes from the skull, through distinct openings, but this difference is not essential, for if the fasciculi of each of the roots of the spinal nerves unite in man before that each root passes through the dura-mater, in the mammalia, they perforate this membrane in three or four points, and before uniting, as is also true of the nerves of which we speak. Comparative anatomy furnishes several other facts which prove the parallel stated by us. In fishes, the anterior and posterior roots of the spinal nerves emerge separately from the spinal column through special openings, so that they are still more similar to the cerebral nerves in this class of the animal kingdom. On the other hand, in most of the mammalia the first cervical nerve, and even the second in some, particularly the hog and the ox, frequently arise entirely from the anterior cord of the spinal marrow, and form only the anterior root of a spinal nerve, which does not emerge through a groove, but through an opening in the first and second cervical vertebræ. In almost all the mammalia the posterior root of the first cervical nerve enlarges into a ganglion long before it unites with the anterior, and before the nerve passes through the first cervical vertebra. The ganglion sometimes divides, as we have often observed in the hog for instance, into two enlargements, an anterior and a posterior, or at least we not unfrequently observe a deep strangulation at its centre and the portion of the posterior root between it and the part of the nerve where it emerges from the vertebral column, forms two in the hog, an anterior and a posterior; this shows

that in this animal, except in the first cervical nerve, the posterior root tends to separate from the anterior, and to become a distinct and special nerve.

From all these remarks it is not difficult to reduce the last four cerebral pairs.

Sœmmerring had already remarked that the glosso-pharyngeal nerve appeared at its origin like each of the spinal nerves; hence, it ought not to be separated from them and be considered an encephalic nerve.(1) The same anatomist compared the origin of the pneumogastric to that of the spinal nerves.(2) Finally, others had considered the accessory as a spinal nerve, or as making the transition from the spinal to the encephalic nerves. But each admits that these comparisons, founded on peculiarities which escape the eye, have no connection with the proposition we establish, viz. that the last four cerebral pairs form in fact only one encephalic nerve, the posterior root of which emerges through the intervertebral foramen, situated between the last and the last but one of the vertebræ of the skull (the occipital and the temporal bones), while the second emerges from it only through the last cephalic vertebra.

The reduction of the other eight pairs is more difficult. Some, however, the common and the external motor, evidently have the characters of anterior roots, or at least of portions of anterior roots; others, as the auditory and the superior motor nerve, present no less manifestly those of the posterior roots. It is more difficult to determine in regard to the rest. We may, nevertheless, compare the facial with the auditory nerve, and consequently with the posterior roots, on account of its course and the nearness of its origin, even as the origin and the course of the trifacial nerve authorize us to arrange it along the anterior roots. As to the two anterior pairs, the second may be compared to a posterior root, because it arises from the tubercula quadrigemina and the optic beds, and the first may be compared to an anterior root. We may then consider four pairs as anterior roots, and four as posterior roots, or as portions of these roots. It is now easy to to refer the auditory, the facial, the trifacial, and the motor nerve, to a single trunk. When we follow the origin of the facial, trifacial, and auditory nerves within the cerebrum and backward, we see that they singularly approach each other. In regard to the facial and the auditory nerve, we must mention beside the nearness of their origins, the remark of Santorini, that we can trace below the transverse fibres of the annular protuberance, to the origin of the auditory nerve, some fibres which from their progress and direction, are evidently the commencement of the facial nerve.(3) The trifacial nerve which partly arises from the olivary bodies, blends here with the sixth pair. The common motor nerve goes from before backward to meet all these

(1) *De basi encephali*; in Ludwiw, *loc. cit.*, p. 103.
(2) *Loc. cit.*, p. 101.
(3) *Septemdec. tab.* p. 23.

nerves in the annular protuberance. The superior motor nerve and the optic nerve, are also very intimately united with them by the band which extends from the medulla oblongata to the tubercula quadrigemina.

The demonstration is most difficult with regard to the two anterior nerves; still the short distance between the origins of the external motor and optic nerves, indicate that the latter depends on the others, and the anterior commissure unites the olfactory and the optic nerves.

II. PARALLEL BETWEEN THE NERVES OF THE UPPER AND LOWER EXTREMITIES.

§ 1899. The nerves of the upper and lower extremities, like the bones, the muscles, and the vessels, are formed essentially after the same type, and differ only by slight modifications of this type, which is subject to the same laws as those of the other three systems.

At first view the number of the pairs of nerves which unite to form the nerves of the two extremities, seem to differ considerably, as there are but five pairs of nerves of the upper extremities, while those of the lower are formed by ten. This difference, however, vanishes on strict examination. In fact, all the cervical nerves are evidently arranged among those which concur to form the brachial plexus, since they are all united and changed into a real plexus like all the lumbar and sacral nerves, by large anastomoses between their anterior branches. Further, the difference in number between the nerves of the two extremities is only one pair. But we may also explain this apparent anomaly by considering the last four encephalic nerves, the glosso-pharyngeal, the accessory, the pneumo-gastric, and the hypoglossal nerves as one pair, which corresponds to the branches of the inferior sacral nerves. This comparison is authorized by the discussion in regard to the origin of these four nerves which we have mentioned, and by considering the manner in which they are distributed. In fact, they give off branches to the tongue and upper part of the intestinal canal, even as the inferior sacral nerves send them to the organs of generation and to the lower part of the intestinal canal.

All these analogies admitted, the number of pairs of nerves in the two extremities is equal: we must not, however, attach much importance to this uniformity of number, nor consume time in endeavoring to establish it, for it is unimportant, but presents itself so naturally, that it would be wrong to neglect it.

We may also proceed in an opposite manner, and decompose the superior and inferior plexuses, considering separately the deep cervical and brachial plexuses above, and the lombo-abdominal and sacral plexuses below, and oppose them to each other. This is Bichat's method. But it is inferior to the other, because it obliges us to separate parts which are united.

The principal common relations between the nerves of the two extremities in their distribution, are as follow:

The superior cervical nerves are distributed to the muscles and integuments of the neck, the same as the superior lumbar nerves are to the muscles and skin of the loins. The first sends some branches to the skin of the shoulder, the suprascapular nerves, while the second furnish some to the skin of the haunch and the arms.

The thoracic nerves correspond to the obturator nerve by their high origin, their course below the bones of the same part, and their distribution to muscles which correspond.

The scapular nerve is the superior gluteal.

The axillary nerve is the inferior gluteal.

The nerves which are distributed lower in the two extremities differ much more, since two twigs and even large branches, which correspond in their mode of distribution, arise from different trunks. The branches, however, are the same, and we can easily explain their differences in respect to origin.

The nerves yet to be compared are in the upper extremity, the internal and the external cutaneous nerve, the radial, the median, and the ulnar nerve; in the lower extremity, the crural and the sciatic nerve.

The external cutaneous radial nerves correspond to the crural: the internal cutaneous, the median, and the ulnar nerve, to the sciatic.

The external cutaneous nerve and the long cutaneous branch of the radial nerve, are evidently the superior and inferior internal saphena nerves of the lower extremity, since they descend along the side of the thumb and of the large toe, which is the internal the the upper limb is in a moderate degree of pronation, and is always so in the lower extremity when it is at rest.

The muscular branches of the crural nerve are the upper branches of the radial nerve. They are distributed in the extensor muscles of the leg, as the latter are in those of the fore-arm.

The analogy, however, between the radial and crural nerves, ceases there. The lower branches given off by the latter are represented in the leg, but come there from the sciatic nerve.

The superior and posterior cutaneous nerves of this latter, very evidently correspond to the upper branches of the internal cutaneous nerve of the arm, since they descend on the outer or fibular side of the little toe, as these latter do on the ulnar side of the little finger.

The tibial nerve corresponds principally to the median and a part of the ulnar nerve. The peroneal represents the lower part of the ulnar nerve, and still more that of the radial. We may compare the posterior cutaneous branch of the tibial nerve, which so frequently arises from the peroneal nerve, to some ramifications of the internal cutaneous brachial nerve.

The muscular branches given by this nerve to the leg correspond to those sent by the median nerve to the muscles of the fore-arm.

The superficial plantar nerve is represented by the superficial palmar branch of the median nerve.

The internal plantar nerve corresponds exactly to the palmar branch of the median nerve.

The external plantar nerve is represented by the palmar branch of the ulnar nerve.

The muscular branch of the peroneal nerve corresponds to the muscular branches of the radial and ulnar nerves of the fore-arm.

The cutaneous branch which is distributed in the back of the foot corresponds by its external twig to the dorsal branch of the ulnar nerve, and by the internal to that of the radial nerve.

§ 1900. The differences here remarked may be easily explained:

1st. Some nerves which arise as distinct trunks in the upper extremity are one nerve in the lower.

2d. Some branches arise from different trunks.

These two anomalies depend on the general difference in the form of the two extremities.

1st. As the fibula, from its smallness and its want of articulation with the tibia, seems reduced in man to a simple constituent part of the tibia; as several muscles of the leg are attached in a common tendon, while others situated in the fore-arm in the upper extremity are found in the sole of the foot; as the external cutaneous vein of the pelvic limb unites with the internal at the knee, while these two veins remain distinct to the axilla in the upper extremity; finally as the arteries often divide very high in the upper extremity, while this anomaly is very rare in the lower, so likewise the nervous trunks which separate very early in the arm, long remain united in the leg.

Farther, the tibial and peroneal nerves are not only sometimes distinct in the pelvis as those of the upper extremity sometimes are in the axilla: but also the cutaneous nerves of the arm are frequently simple branches of the three larger nerves. The difference mentioned above in the crural nerve during its development, also establishes a greater analogy between the two limbs in the early periods of life than at a more advanced age.

2d. The difference in origin depends partly on the preceding fact, partly also on the difference in the direction and situation of the two extremities. If the arm is in the state of pronation, and thus possesses a direction similar to that of the lower extremity, these differences are explained with facility.

The radial nerve is then drawn up as high as the elbow, so that we may imagine it to terminate here, and that its lower part unites with the ulnar nerve.

The antibrachial parts of the median and ulnar nerves are also approximated, and they blend in a single trunk which divides into two branches at the palm of the hand.

BOOK VI.

SPLANCHNOLOGY.

§ 1901. Splanchnology, or the branch of anatomy which treats of the apparatus for the functions, includes the description of the most complex parts of the organism, those formed by the union of a greater or less number of simple organs or systems. We cannot consider these as belonging to the class of those already mentioned, as they differ too much from these latter or from each other. We must however remark that they may finally be referred in respect to their essential characters to the cutaneous and glandular systems.

In regard to their functions they may be divided into two classes, one of which establishes an immaterial, the other a material connection between the organism and the external world. The first are the *organs of sense*, the others are properly termed the *viscera*.

The *organs of the senses* perceive actively the impressions of qualities belonging to the body which they contribute to form, or to external objects. They transmit them to the brain by means of their nerves, and cause in this viscus the formation of *ideas*, that is, they there produce modifications of the principle of the mind, of which it is the immediate organ.

Some of the *viscera* receive foreign external substances, others remove all that the vital powers have rendered useless, or separate parts proper to form similar new bodies, that is, they remove from the organism all that is useless and which cannot serve to preserve the species. Some of these organs, as the intestinal canal and the lungs, perform both of these functions at the same time; others, as the kidneys and genital organs, serve only for the excretory function; they all have this in common, that they form new substances, and that they thus preserve the individual in the normal state. The substance formed by the genital organs serves also and in a special manner to preserve the species.

However different the results and the mode of action of the organs of sense and the apparatus of formation may be, the first are in regard to mind exactly the same as are the second in relation to the body. Farther the inferior senses, those of smell, taste, and touch, which are the bases of all, insensibly establish the transition from the superior senses, those of sight and hearing, to the proper viscera, both in respect to their form and situation, and to their mode of action. We may also

admit that the organs of sense and the viscera have several characters in common; these are:

1st. They are developments of the cutaneous system.

2d. They are mostly or entirely situated in more or less perfect bony cavities.

3d. They are prolonged outward by valvular folds of the skin, which are provided with simple glands and hairs.

4th. There is only one or at most but two: in the former case they are situated so that the median line divides them into two equal parts; in the second there is only one on each side, a right and a left.

As the direct organ of the spiritual principle is that which we considered last, it is most convenient to examine first the organ of the most intellectual sense, that of hearing, and next to treat of that of sight, that of smell, and lastly the organ of taste, which forms a part of the digestive apparatus. After describing this apparatus we shall pass to the organs of respiration and of voice, then to those of the urinary secretion, and lastly to those of generation and the history of the fetus.

SECTION I.

OF THE ORGANS OF SENSE.

§ 1902. All the *organs of the senses*(1) are similar in the following characters:

1st. *They are situated in the head.* The organ of hearing is placed the farthest backward and belongs entirely to the skull; it is also situated the most on the side, and its two lateral portions are entirely distinct from each other. The cavity occupied by the eye is partly formed by the bones of the skull and mostly by those of the face. That of the olfactory organ belongs still more to the face, in fact almost exclusively to it, since the ethmoid bones form less of the skull than of the face. The cavity of the mouth is formed only by the bones of the face. The right and left portions also gradually approach each other from the organ of hearing to that of taste, so that they finally blend in the tongue.

2d. *They are all connected by short and large nerves with the encephalon.* The auditory is proportionally the shortest and largest nerve. It arises from the *calamus scriptorius* as from a distinct cavity, so that

(1) A. Molinetti, *Dissertationes anatomicæ et pathologicæ de sensibus et eorum organis*, Padua, 1669.—Casserio, *Pantæsthesejon, hoc est de quinque sensibus liber, organorum fabricam, usum et actionem continens*, Venice, 1699.—Haller, *De sensibus in genere*, Gottingen, 1742.—Lecat, *Traité des sens*, Amsterdam, 1744.—Sœmmerring, *Abbildungen der menschlichen Sinnorgane*, Francfort, 1809.

no other nerve of the organs of sense is connected so intimately with the mass of the encephalon.

3d. *All receive their nerves from at least two pairs.* The larger nerve is termed the *nerve of sense*, and the smaller the *accessory* nerve. In the organs of hearing, smell, and taste, the nerve of sense forms as many distinct pairs, the auditory, optic, and olfactory nerves, while in that of taste it is only a branch of the trifacial nerve, which is also the common trunk of the accessory nerves; but this includes also the hypoglossal, the glosso-pharyngœal and the facial, the three motor and the ganglionnary nerves. The names of several of these nerves prove that the accessory nerves serve principally to excite the motions of the organs of sense. The olfactory nerve is the only one which is to a certain extent an exception to the rule, since its proper accessory nerves, like its nerve of sense, are distributed in the mucous membrane of the nose. The nerves of sense and the accessory nerves are not necessarily connected; these connections do not exist in the organs of sight and hearing. They are slight and probably inconstant in the organ of smell, and are well developed only in the tongue, which is the most similar to the general organ of touch.

4th. *The proper nerves of sense expand more or less evidently as a thin membrane*, which is covered directly by a fluid above which is a tissue similar to the epidermis.

5th. *They all communicate by ducts more or less broad*, the prolongations of the internal cutaneous membrane which make part of them, and which perform a part as much more important in their organization the less they are developed. The more similarity there is between them, as between the organs of taste and smell, the more loose and extensive the communication, so that so they really form but one in the early periods of life, at which time the roof of the palate which will separate the last two from each other is not yet formed. The communication between these two organs of sense and the others is more marked the nearer the fetus is to its period of formation.

In fact the cutaneous system is more or less evidently the prototype of all the organs of sense, and the external integuments are the seat of sensation, as the hand is that of the special modification of the general sensation termed the touch.

CHAPTER I.

OF THE ORGAN OF HEARING.

§ 1903. The *organ of hearing*,(1) or the *ear*, is situated at the centre of the side and the base of the skull within and on the surface

(1) Fallopius, in his *Obs. anat.*, Venice, 1561; *Opp. omn.*, vol. i., tr. ii.—Eustachius, *De auditus organo;* in the *Opusc. anat.*, Venice, 1564.—Fabricius d'Aquapendente,

of the temporal bone. This organ, the most noble and the most intellectual of the senses, belongs entirely to the skull. It is connected with the encephalon more directly, and is protected better against external injuries than any other of the senses.

It is formed of a considerable number of parts differing very much in their form and texture, and which may be divided generally into two sections, comprehending the *external* and the *internal* ear.

ARTICLE FIRST.

EXTERNAL EAR.

§ 1904. The *external* ear, *oricule*, Ch. (*auris externa*),(1) is formed by the cartilage of the ear, the cartilaginous portion of the external auditory passage, and several muscles which are attached to the different regions of the auricular cartilage. All these parts are covered by the common integuments.

A. CARTILAGE OF THE EAR.

§ 1905. The *cartilage of the ear* (*cartilago auris*),(2) considered generally, is formed like a short tunnel with a broad oval opening larger from above downward than from before backward. This surface is very uneven from several prominences and depressions which circumscribe this opening.

De visione, voce et auditu, Venice, 1688.—J. Mery, *Description exacte de l'oreille*, Paris, 1681.—Duverney, *Traitè de l'organe de l'ouie, contenant la structure, les usages et les maladies de toutes les parties de l'oreille*, Paris, 1683.—C. G. Schelhammer, *De auditu liber anus*, Leyden, 1684. A. M. Vasalva, *Tractatus de aure humanâ*, Bologna, 1704.—R. Vieussens, *Traitè de la structure de l'oreille*, Toulouse, 1714.—J. F. Cassebohm, *Tractatus quatuor de aure humanâ*, Halle, 1734; *Tractatus quintus et sextus*, Halle, 1735.—Morgagni, *Ep. anat.*, ep. iv., v., vii., xii., xiii.—Geoffroy, *Dissertations sur l'organe de l'ouie de l'homme, des reptiles et des poissons*, Amsterdam, 1788.—C. P. C. Wildberg, *Versuch einer anatomisch-physiologisch-pathologischen Abhandlung über die Gehörwerkzeuge des Menschen*, Jena, 1795.—Sœmmerring, *Abbindungen der menschlichen Gehörorgane*, Francfort, 1806.—J. S. Schrocter, *Das menschliche Ohr, nach den Abbildungen Sœmmerrings vergróssert dargestellt*, Weimar, 1811.—J. Cunningham.—Saunders, *The anatomy of the human ear, illustrated by a series of engravings of the natural size, with a treatise on the diseases of that organ, the causes of deafness, and their proper treatment*, 1817.—C. S. Pohl, *Expositio generalis anatomica organis auditus per classes animalium*, Vienna, 1818.—T. H. Weber, *De aure et auditu hominis et animalium*, Leipsic, 1820.—J. Van der Hœven, *Diss. de organo auditus in homine*, Utrecht, 1822.

(1) D. Santorini, *De auris interna*, in the *Observat. anatom.*, Venice, 1724, ch. ii.

(2) B. S. Albinus, *De cartilagine auriculæ;* in the *Annot. academ.*, lib. vi., cap. vii., tab. iv.

1st. The most external eminence which mostly surrounds all the others is called the *helix*.

It begins at the centre of the anterior edge of the external ear, goes first from below upward to the upper extremity of the auricular cartilage, then curves backward, and finally descends to the posterior part of the circumference of the ear and terminates imperceptibly at its lower extremity.

2d. A second eminence surrounded by the preceding, and termed the *anthelix*. It begins below and behind near the lower extremity of the helix, goes upward and forward, separates a little from this latter and divides at its upper and anterior extremity into a superior and an inferior branch, which extend to near the ascending portion of the helix where they gradually terminate.

3d. Opposite the commencement of the helix is a third square eminence which forms the anterior and inferior part of the cartilage of the ear. It is termed the *tragus*.

4th. Opposite the tragus we observe posteriorly a similar prominence termed the *antitragus*, separated by a groove from the preceding. The helix and the anthelix terminate here.

§ 1906. The depressions between these different prominences are:

1st. The *scaphoid* or *navicular* fossa (*fossa scaphoidea*), a slight depression which is concave forward, convex backward, and which extends between the posterior part of the helix and anthelix.

2d. The *anonymous triangular* or *oval* fossa (*fossa anonyma*, s. *triangularis*, s. *ovalis*), which extends between the two branches of the anthelix.

3d. The *concha* (*concha auris*), a deep cavity which serves as the entrance to the cartilaginous portion of the auditory passage. It is situated between the helix, the tragus, and the antitragus.

4th. The *groove of the ear* (*incisura auris*), situated between the helix and the tragus.

§ 1907. The lower part of the external ear or the *lobule* (*auriculus*, s. *lobulus aurus*), has no cartilaginous frame. It is only a simple prolongation of the skin filled with fat and mucous tissue.

The cartilage of the ear extends at its lower part into a semicanal, which is open above and is termed the *auditory passage*, the *auricular* or *oricular* channel (*meatus auditorius cartilagineus*). This canal commences at the anterior part of the external ear, where it is more or less covered by the tragus like a valve. Its direction is at first transverse from without inward, or even a little from below upward: it then becomes in most of its course oblique from below upward and from before backward. It is terminated above by the long posterior root of the zygomatic process of the temporal bone, and below this root by some fibrous tissue.

The cartilage of the auditory passage, which is only a prolongation of that of the ear, is generally interrupted in some portions of its extent.

The principal space is in part where the direction of the passage is changed in the manner mentioned. There in fact the internal and external portions of its cartilage are not united above and below except by a narrow band.

The cartilage also presents at its external part a second smaller band, which descends from its upper edge and extends along its anterior wall.

The cartilaginous auditory passage is much shorter from before backward, than from above downward. It is about an inch long, four lines high, and three broad. Its inferior part extends inward and downward some lines farther than the upper.

It is attached to the adjacent parts of the temporal bone by a firm, short cellular tissue. Its internal orifice particularly unites to the asperities of the external orifice of the bony portion of the auditory passage, of which this cartilaginous portion is the continuation.

§ 1908. The cartilage of the external ear is entirely covered on its external and its internal face by the skin which intimately adheres to its inequalities. It gradually becomes thinner from without inward, moister and more analogous to a mucous membrane. The entrance of the auditory passage is generally furnished with short thin hairs which are arranged very compactly. The skin which lines it usually presents on its inner face a considerable number of broad rounded openings. These openings lead to a glandular and reddish layer, which surrounds them and secretes the *wax* (*cerumen aurium*), a thick yellowish, viscous, very inflammable fluid, in which chemical analysis demonstrates a fatty oil, a peculiar albuminous and a coloring substance.(1)

B. MUSCLES OF THE EXTERNAL EAR.

§ 1909. The cartilage of the external ear is provided with several muscles(2) which are generally thin and small, and may be referred to two classes: one includes those which move the whole external ear, and thus contribute to change its situation and direction; the other is composed of those which move only some of its parts, and modify more or less evidently its general form.

I. MUSCLES WHICH MOVE ALL THE EXTERNAL EAR.

§ 1910. These muscles are the *attollens auriculæ*, the *retrahentes auriculæ*, and the *attrahens auriculæ*.

(1) Berzelius observes (*Djurkmei*, vol. ii. p. 230) that the cerumen ought also to contain water, and it is not well proved that the albuminous substance is truly of this nature. Rudolphi considers the bitter principle of the cerumen to be the same as that of the bile. F. T.

(2) D. Santorini, *Obs. anat.*, cap. i. tab. 1; *ejusdem Tab. posth.*, vol. i.—A. F. Walter, *Anatome tenuiorum musculorum corporis humani reptila*, with the table of Santorini.

a. Attollens auriculæ.

§ 1911. The *attollens auriculæ* muscle, the *superior auricular* muscle, *temporo-oriculaire*, Ch., the largest muscle of the ear, is thin and triangular. It arises from the centre of the aponeurotic envelop of the skull and the aponeurosis of the temporalis muscle, contracts from before backward, and is attached to the eminence of the auricular cartilage, which corresponds to the triangular depression between the two branches of the anthelix.

It elevates the ear, particularly during the action of the occipito-frontalis muscle, as it arises from the median tendon of this muscle.

b. Retrahentes auriculæ.

§ 1912. There are generally three *retrahentes auriculæ* or *posterior auricular* muscles, *mastoido-oriculaires*, Ch. Sometimes there are but two, more rarely four, the inferior of which is very thin. These muscles are always situated successively from above downward, are very small, thin, and elongated. They arise from the mastoid process, and are attached by short tendinous fibres to the centre of the external face of the ear, on the eminence which corresponds to the entrance of the auditory organ.

Their inferior extremity is often blended with the occipitalis, or with the complexus or the sterno-cleido-mastoideus muscles.

These muscles draw the ear backward, and slightly dilate the concha.

c. Attrahens auriculæ.

§ 1913. The *attrahens auriculæ* muscle, the *anterior auricular* muscle, *zygomato-oriculaire*, Ch., is also very small, but always a little larger than the preceding. It arises on the zygomatic process, goes backward and downward, gradually contracts, and is attached by a short tendon to the inferior and anterior transverse portion of the helix, which forms the commencement of this eminence.

It carries the ear forward and upward.

II. MUSCLES WHICH MOVE CERTAIN PARTS OF THE EXTERNAL EAR.

§ 1914. The muscles which move certain parts of the external ear are extremely small and weak, particularly in civilized nations. Being used but slightly or not at all, they cannot modify the form of the external ear, and may be considered as rudiments of those which are much more developed in animals. All are thin, and are attached by all their internal face to the part of the ear which they move.

They are the *tragicus*, the *antitragicus*, the *helicis major*, the *helicis minor*, and the *transversus auriculæ muscles*.

a. Tragicus muscle.

§ 1915. The *tragicus* muscle, *tragien*, Ch. is oblong. It arises from the inferior and anterior part of the concha, directly below the tragus, which it covers outwardly. Its superior edge is situated below the lower extremity of this eminence. It rarely goes farther, and extends to the lower extremity of the anterior edge of the helix, in which case it is even blended with the helicis major muscle.

It carries the tragus outward, and thus shows the orifice of the concha.

b. Anti-tragicus muscle.

§ 1916. The *anti-tragicus muscle*, *antitragien*, Ch. arises from the upper extremity of the external face of the antitragus, and is attached to the lower extremity of the anthelix.

It approximates these two eminences, and carries the anti-tragus a little backward and outward.

c. Helicis major muscle.

§ 1917. The *helicis major* muscle, *grand helicien*, Ch., is elongated. It arises from the inferior extremity of the helix, and ascends on the external and anterior face of this eminence, to which it is attached directly above the point where the ear separates from the head.

It draws the anterior part of the concha a little backward and downward.

d. Helicis minor muscle.

§ 1918. The *helicis minor* muscle, *petit helicien*, Ch., is the smallest muscle of the external ear. It is situated like the preceding, on the external face of the helix; it arises much lower and more posteriorly than it, in the place where this eminence leaves the external ear, and is attached sometimes higher to its ascending portion near the posterior edge.

It slightly depresses the anterior part of the helix.

e. Transversus auriculæ muscle.

§ 1919. The *transversus auriculæ* muscle, *transverse de l'oricule*, Ch., is situated on the internal face of the external ear, viz. that which looks towards the head. It is larger than the preceding, but is formed of fasciculi which are less cohcrent, and generally also less evidently fleshy. Its direction is transverse in almost all its course, and it extends from the anthelix to the scaphoid fossa.

It draws the scaphoid fossa and the helix outward, and thus enlarges the opening of the ear.

ARTICLE SECOND.

INTERNAL EAR.

§ 1920. The *internal ear* (*auris interna*)(1) comprehends:

1st. A considerable portion of the temporal bone, especially the petrous and mastoid processes.

2d. The small bones of the ear, which moveably articulate with the temporal bone.

3d. The muscles which move these little bones.

4th. A cartilaginous channel by which the ear communicates with the cavity of the mouth.

5th. A fibro-cartilaginous expansion contained within the bony portion of the ear.

6th. The auditory nerve which is distributed to this expansion.

A. EXTERNAL PORTION.

I. OSSEOUS PORTION OF THE AUDITORY PASSAGE.

§ 1921. The *osseous portion of the auditory passage*, *conduit auriculaire*, s. *oriculaire*, Ch. (*meatus auditorius osseus*), when perfectly developed, forms the posterior and external part of the lower face of the petrous process of the temporal bone. It is an elliptical canal, the direction of which is from above downward, from behind forward, and from without inward, which gradually contracts in the same direction. This canal is about half an inch long. Its height exceeds its breadth.

Its external orifice which presents grooves and asperities on its edge, is called the *external auditory foramen* (*porus acusticus externus*, *aditus ad meatum auditorium osseum*). It is turned from within outward, and is intimately united to the cartilaginous portion of the auditory passage.

Its posterior wall is a little shorter than the anterior. It is lined in its whole extent by a prolongation of the skin which covers the ear, and which gradually becomes thinner from without inward.

Its internal orifice presents a considerable depression, a groove in which the membrane of the tympanum is situated. This groove extends all around it, except its upper portion.

(1) C. Folius, *Nova auris internæ delineatio*, Venice, 1645.—B. S. Albinus, *De aure humanâ anteriore;* in the *Annot. acad.*, book iv., cap. ii.—A. Comparetti, *Observationes anatomicæ de aure internâ comparatâ*, Padua, 1789.—A. Monro, *On the brain, the eye and the ear*, Edinburgh, 1797.—Ribes, *Mémoire sur quelques parties de l'oreille interne;* in the *Bulletin de la soc. méd. d'émul.*, 1823, November, p. 650 December, p. 707.

II. MEMBRANE OF THE TYMPANUM.

§ 1922. The *membrane of the tympanum* (*mem. tympani*),(1) which is inclosed in the internal orifice of the auditory passage, separates the canal from that part of the internal ear which is next to it, that is from the cavity of the tympanum.

It is a thin, elliptical membrane, the direction of which is a little oblique from above downward, from without inward, and from behind forward. There is positively no opening in it in the normal state, although the contrary opinion has been maintained in several different forms.(2) It consequently completely separates the cavity of the tympanum and the labyrinth from the osseous portion of the auditory passage and from the external ear. As it extends a little farther than the opening which receives it, its form changes in regard to its degree of tension and relaxation,(3) which is produced principally by the action of the muscles of the little bones of the ear. It fits exactly into the groove at the internal extremity of the auditory passage.

Anatomists differ in opinion in regard to the formation of the membrane of the tympanum. The most correct consider it formed of a special membrane situated in the centre, of a second which is external, situated next to that of the bony portion of the auditory passage. In this view of the subject the external layers would be culs-de-sac of the internal and the external cutaneous system, while the middle layer forms a distinct and special membrane arising from the bony portion of the auditory passage.

This special membrane presents very distinct fibres which radiate from its centre to its circumference, and are very manifest in its internal face. Judging from analogy, that is from what occurs in the large animals particularly the elephant, these fibres are probably muscular.(4) The most careful injections demonstrate also numerous blood-vessels which come principally from two circular trunks, an external and an internal, and which anastomose together frequently.

(1) A. F. Walther, *De membrana tympani*, Leipsic, 1725.—Brugnone, *Observations anatomiques sur la structure de la membrane du tympan et de celle de la caisse;* in the *Mém. de Turin*, an. xii., p. 1,12.—E. Home, in the *Phil. trans.*, 1804.

(2) Very recently even Vest, judging from his own observations and those of Wittmann, has maintained the normal existence of an opening in the membrane of the tympanum, admitted some time since by Rivinus, and long neglected. He asserts that this opening is oblique, and thus forms a kind of valve. But he admits it is frequently deficient (*Uuber die Wittmann' sche Trommelfellklappe;* in the *Medicinische Jahrbücher des Oesterreichischen Staates*, vol. v., Vienna, 1819, p. 123-133). To conclude from a few cases, which were probably morbid, that the opening is formed primitively, is evidently to make the exception a rule. F. T.

(3) F. Savart, *Recherches sur les usages de la membrane du tympan et de l'oreille externe;* in the *Journal de physiol. experiment.*, vol. iv., p. 183.

(4) Sir E. Home asserts he has found some muscular fibres in the membrane of the tympanum in the elephant. Their existence is at least doubtful. Rudolphi has observed nothing similar in the whale or horse. F. T.

Of the two superficial layers the external is easily insulated: but it is more difficult to separate the internal from the middle, both on account of its fineness and because it adheres to this latter more intimately.

B. MIDDLE PART.

I. TYMPANUM.

§ 1923. The *tympanum* or the *drum* (*tympanum*, s. *cavitas tympani*)(1) is a narrow, rounded cavity, which is generally convex internally and which is continuous outwardly with the osseous portion of the auditory passage by a broad opening before which the membrane of the tympanum is expanded, and forward with the Eustachian tube through another narrower opening. This cavity forms the central part of the internal ear; hence some anatomists term it the *middle ear*, in opposition to the labyrinth and all the parts on the outside of it. It occupies the external and posterior part of the petrous portion and communicates anteriorly with the cavity of the mouth, posteriorly with the mastoid cellules.

Its internal and very irregular face presents numerous elevations and depressions which are connected with the labyrinth. It incloses the little bones of the ear and the cord of the tympanum.

When we consider only the bones, we perceive that it is open forward, backward, and downward. A mucous membrane which is continuous with that of the throat lines its whole extent.

§ 1924. On the inner face of the cavity of the tympanum, forward and downward, at about its centre is a considerable eminence, termed the *promontory* (*promontorium*), formed by the commencement of the cochlea, and always covered by osseous substance.

At its lower and posterior part is an oblong, triangular opening, more high than broad, which is directed backward and outward; this is the *fenestra rotunda*, the *cochlear* opening of the *tympanum*.(2) This opening communicates with the cochlea, but it is closed by the mucous membrane which lines the whole cavity of the tympanum.(3)

Above the promontary and a little above the centre of the tympanum is a second and much larger opening, called the *fenestra ovalis*, the *vestibular opening of the tympanum* (*fenestra ovalis*, s. *semi-ovalis*). The length of this opening, the greatest diameter of which is directed from above downward and from before backward, exceeds its breadth.

(1) Santorini, *Opp. posth.*, tab. v.

(2) A. Scarpa *De structurâ fenestræ, rotnndæ auris, et de tympano secundario anatomicæ observationes*, Modena, 1772.—Ribes, *loc. cit.*, p. 652.

(3) Ribes asserts that the membrane of the fenestra rotunda is composed of a special layer, of a second given off by that of the cavity, and of a third coming from that which lines the internal scala of the cochlea. Its structure then resembles that of the membrane of the tympanum. F. T.

Its posterior edge is convex, the anterior is straight. It is surrounded outward by a small groove.

On the posterior wall of the cavity of the tympanum opposite the lower extremity of the fenestra ovalis, farther backward and much more outward, we remark the *pyramid* (*eminentia pyramidalis*), a small triangular eminence which terminates forward by an opening which is grooved in it, and which communicates with the Fallopian canal: from the anterior extremity of this a small bridge of bone is frequently detached, which goes to the upper extremity of the promontory, below the fenestra ovalis.

Below and more posteriorly is another opening (*apertura chordæ*) through which the cord of the tympanum passes from the Fallopian canal to the tympanum.

The space between the pyramid, the promontory, and the fenestra ovalis forms a considerable depression termed the *sinus of the tympanum* (*sinus tympani*).

Above and in the centre the cavity of the tympanum is grooved to receive the upper part of the two largest bones of the ear.

Upward and backward it communicates by one or more considerable openings with the cavity of the mastoid process, which must consequently be considered as a prolongation of it. This cavity is divided by numerous septa into cellules, which enlarge much from the centre to the circumference, and which are lined by the mucous membrane which covers the inner face of the tympanum.

The internal wall of the tympanum presents at its anterior part a groove which leads into an osseous prolongation; this extends forward, and is the *bony portion of the Eustachian tube* (*tuba Eustachii ossea*). Above this groove we observe a second, which sometimes is not separated from the other in its whole extent, and which lodges the tensor tympani muscle.

Under the posterior extremity of the second groove is a small opening which leads above to the superficial petrous groove, below to a groove which descends on the promontory. This groove becomes at its lower part a canal which opens outward on the lower face of the pyramid, between the carotid canal and the fissure of the jugular vein.

Through this canal passes a filament of anastomosis between the second branch of the trifacial, the glosso-pharyngœal, and the ganglionnary nerve; this minute filament arises from the superficial petrous nerve, enters the cavity of the tympanum with another filament of the great sympathetic nerve, and communicates below this cavity with the ganglion of the glosso-pharyngœal nerve.(1)

(1) Jacobson, *Supplementa ad otoiatriam*; in *Act. Hafn.*, vol. v., 1818, p. 292.

II. EUSTACHIAN TUBE.

§ 1925. The *Eustachian tube, conduit guttural de l'oreille*, Ch. (*tuba Eustachii*), is a canal the posterior part of which is formed of bone, but is fibrous and fibro-cartilaginous at its anterior portion, and extends from the tympanum to the upper part of the pharynx. The direction of this canal is oblique from above downward, from without inward, and from behind forward. It is nearly two inches long.

The osseous portion is the shortest, and is situated above the carotid canal. It becomes narrow from behind forward.

The cartilaginous portion proceeds directly below the base of the skull, but on the contrary gradually enlarges in the same direction. It is compressed from within outward in its whole extent. Its form is elliptical and it is fibro-cartilaginous in the inner portion and sometimes also in the upper portion of its external wall. In other parts it is composed of a fibrous tissue which arises from the periosteum of the inferior pterygoid process.

The Fallopian tube is entirely lined internally by a very fine mucous membrane which is continuous with that of the oral cavity and of the tympanum. Around the buccal orifice of this tube this membrane becomes much thicker, partly from a great development of the muciparous glands. Thence a prominence is formed which changes this opening into a narrow longitudinal fissure and forms a kind of valve.

III. BONES OF THE EAR.

§ 1926. The *bones of the ear* (*ossicula auditus*),(1) situated at the upper part of the cavity of the tympanum, are the smallest bones in the body. They form a chain composed of pieces movably articulated with each other, which extends from the membrane of the tympanum to the fenestra ovalis, consequently to the labyrinth, and which conveys to the deepest parts of the internal ear the changes which supervene in the membrane of the tympanum.

There are three bones, the *hammer* (*malleus*), the *anvil* (*incus*), and the *stirrup* (*stapes*); and in the early periods of life a fourth, the *lenticular* bone.

(1) J. A. Schmid, *De periostoo ossiculorum auditus ejusque vaseculis*, Leyden, 1719. —H. F. Teichmeyer, *Diss. medica solemnis sistens vindicias quorundam inventorum anatomicorum*, Leipsic, 1727.—Magendie, *Sur les organes qui tendent ou relâchent la membrane du tympan et la chaine des osselets de l'ouïe dans l'homme et dans les animaux mammifères*; in the *Jour. de phys. expèrim.*, vol. i., p. 341–347, tab. iv.

a. Malleus.

§ 1927. The *hammer* (*malleus*) forms the anterior and external part of the chain, and is divided into a *head*, a *neck*, a *handle*, and *processes*.

The *head*, the upper part, is rounded, oblong, convex and smooth forward, concave and slightly uneven backward. Its posterior face is oblong and surrounded by a slightly prominent edge. A transverse eminence divides it into an upper and a lower face.

The head is situated above the inferior edge of the membrane of the tympanum in the anterior part of the upper prolongation of the cavity of the tympanum.

The *neck* is short, compressed in all parts, but particularly slightly flattened from without inward.

Its lower extremity is divided into three sections, the *handle* and the two *processes*.

The *handle* (*manubrium*), or the inferior section, descends a little from without inward and from behind forward. It is terminated at its lower extremity by a small prominence, and is situated between the layers of the membrane of the tympanum.

The *external* or the *short process* (*processus externus*, s. *obtusus*, s. *brevis*) projects more or less at the upper extremity of the handle, and forms with it a right angle. It is directed outward, and is separated by a deep groove from the head, into which the upper side of the internal extremity of the auditory passage enters.

The *anterior long* or *spinous process* (*processus anterior*, s. *longus*, s. *spinosus*) is thinner but much longer than the preceding, and is convex above and concave below. It is received by a broad and superficial groove hollowed on the inner face of the upper extremity of the ring of the tympanum.

The malleus is connected with the membrane of the tympanum and with the incus.

b. Incus.

§ 1928. The *anvil* (*incus*) has nearly the form of a bicuspid molar tooth; it is composed of two branches and of a centre which may be termed the *body*.

The *body* is almost square, flat, and presents forward a concave surface by which the bone articulates with the head of the malleus (§ 1926). It is situated above the membrane of the tympanum.

The *upper* or *posterior* and *shorter* branch is flattened from within outward, terminated by a blunt summit also situated above the membrane of the tympanum, and is directed horizontally from before backward where its loose extremity terminates.

The *anterior* or *inferior* branch varies in length and is almost straight; its direction is from above downward and from behind forward, and it is situated more internally than the preceding. It terminates in a small button-like prominence; it is situated behind the handle of the malleus, a little on the outside of it.

The body of the incus articulates above and forward with the head of the malleus, by its long branch below with the stapes. It is not directly connected with the membrane of the tympanum.

c. Lenticular bone.

§ 1929. The *lenticular* bone (*os lenticulare*, s. *Sylvii*) is an extremely small, flat, and rounded bone, situated on the inner face of the lower extremity of the long branch of the incus. It generally fuses with the incus very early, even during the latter months of pregnancy, and then forms an eminence which projects on its inner face.

d. Stapes.

§ 1930. The *stirrup* (*stapes*) is situated more internally than the other two bones of the ear, and is not perpendicular like them but horizontal. It is composed of a *head*, two *branches*, and the transverse face or the *base*.

The *head* is rounded, oblong, and flattened from above downward. Its upper extremity looks outward and presents a slight depression for the lenticular bone: the two branches are sometimes separated by a contracted *neck*.

The *anterior* branch is always shorter and also straighter than the *posterior* branch. Both are grooved on their internal faces, which look towards a groove in which a membrane, a prolongation of that of the tympanum, extends between them.

The *base* has exactly the same form as the fenestra ovalis, with which it is movably united by the membrane of the tympanum. It is always a little narrower, so that it can enter and leave the vestibule through this opening.

Its inner face, which corresponds to the fenestra, is straight. The external is concave and circumscribed by prominent edges.

IV. MUSCLES OF THE BONES OF THE EAR.

§ 1931. The small bones of the ear are moved by four muscles, which, like the bones to which they are attached, are the smallest in the body. Three of these are inserted in the malleus and one in the stapes. Two muscles of the malleus are situated before the cavity of the tympanum, the third above this cavity. That of the stapes is situated behind it. The incus has no special muscle: it forms only a connecting link between the malleus and the stapes.

a. Muscles of the malleus.

§ 1932. The three muscles of the malleus from their connections of the bone with the membrane of the tympanum vary the degree of tension of this membrane. They are distinguished into an *internal* and an *external.*

1. Tensor tympani muscle.

§ 1933. The *tensor tympani* muscle, the *internal muscle of the malleus* (*m. tensor tympani*, s. *mallei internus*) is elongated. It arises from the upper part of the cartilaginous portion of the Eustachian tube near the sphenoid bone, and generally comes from its large wing. Its direction is from before backward in the canal from which the petrous process is grooved to allow it to pass to the osseous portion of the tube. In the cavity of the tympanum the direction of its tendon changes, leaves the internal wall of this cavity, goes outward and is attached to the upper extremity of the inner face of the malleus directly below its long process.

This muscle draws the malleus inward, tenses the membrane of the tympanum which the bone draws with it, and brings the chain of bones inward so as to sink the stapes into the fenestra ovalis.

2. Laxator tympani major muscle.

§ 1934. The *laxator tympani major* muscle, the *great external muscle of the malleus* (*M. laxator tympani major*, s. *mallei externus major*), arises from the grooved prolongation of the great wing of the sphenoid bone, and is directed from without inward and from before backward. Its tendon enters the fissure of Glaser and is attached to the long process of the malleus.

It draws the malleus forward and outward, and thus relaxes the membrane of the tympanum.

3. Laxator tympani minor muscle.

§ 1935. The *laxator tympani minor* muscle, the *small external muscle of the malleus* (*M. laxator tympani minor*, s. *mallei externus minor*), is much smaller than the two preceding and arises from the upper edge of the osseous portion of the auditory passage, passes between the layers of the membrane of the tympanum, goes forward and outward, and is attached sometimes higher and sometimes lower to the handle and the external process of the malleus.

It draws the malleus upward, backward, and outward. It consequently relaxes the membrane of the tympanum.

b. Stapedius muscle.

§ 1936. The *stapedius* muscle (*M. stapedius*) is oblong and triangular. It arises at the base of the pyramid and goes forward and upward. Its tendon comes through the anterior opening in the top of the pyramid, and is attached to the posterior part of the head of the stapes.

It draws the stapes backward so as to bring the posterior portion of its base into the fenestra ovalis. It also draws the chain of the bones inward, and thus tenses the membrane of the tympanum.

We have every reason to think that it acts at the same time as the tensor tympani muscle.

C. INTERNAL PORTION OR LABYRINTH.

§ 1937. The *labyrinth* (*labyrinthus*),(1) the most internal part of the organ of hearing, comes next inside to the tympanum. It is a double cavity situated in the petrous portion of the temporal bone, directly surrounded by the very firm substance of this portion, and is formed of several compartments of very complex figures. We distinguish in it a *central* part the *vestibule*, a *posterior* part the *semicircular canals*, an *anterior* portion the *cochlea*, and the *lateral* parts the *aqueducts*.

One of the two cavities which form it completely surrounds the other and is moulded upon it.

The first is the *osseous labyrinth*, the second the *membranous labyrinth*.

I. OF THE OSSEOUS LABYRINTH.

§ 1938. The *osseous labyrinth* in the adult is not distinct from the compact substance of the petrous process of the temporal bone, of which it forms the most internal, the firmest and the hardest part, which closely envelops and covers the membranous labyrinth. But in the early periods of life it is formed by a solid, hard, and brittle substance, separated from the external layer of the petrous process by a less compact osseous tissue. Its internal face is moistened with limpid serum which exactly fills all the space between it and the membranous labyrinth.(2)

During the early periods of life we find between the two labyrinths a membrane which is not the periosteum of the osseous portion, although generally considered as such, but which belongs to the class

(1) A. Scarpa, *Disquis. anatomicæ de auditu et olfactu*, Pavia, 1789.—A. Monro, *loc. cit.*—Brugnone, *Observations anatomico-physiologiques sur le labyrinthe de l'oreille ;* in the *Mémoires de Turin*, 1805-1808, p. 167-177.

(2) Cotugno, *Diss. cit.*, § xxix.—P. F. T. Meckel, *De labyrinthi auris contentis*, Strasburg, 1777.

of sero-mucous membranes. This is demonstrated by the numerous vessels it receives and by its abundant secretion and its connections with the membrane of the tympanum.

a. Vestibule.

§ 1939. The *vestibule* (*vestibulum*),(1) the middle of the bony labyrinth, is situated farther inward and more posteriorly than the tympanum. It is of a rounded and oblong cavity at about the centre of which we perceive the internal orifice of the fenestra ovalis. We there remark principally two small depressions or superficial grooves, one *superior, posterior* and *external*, more extensive than the other and of an oval form (*fovea*, s. *cavitas ovalis*, s. *elliptica*, s. *semi-elliptica*) ; the other *inferior* and *anterior*, smaller and semicircular (*fovea hemisphærica*, s. *orbicularis*). The first is situated on the posterior and inferior wall, the second on the superior and external. They are separated by a sharp crest which extends from above downward.

The oval fossa is continuous below with another which is smaller, the *sulciform* groove (*fovea sulciformis*).

§ 1940. In the circumference of the vestibule are six large foramina and one which is rounded and very small.

Of these six large foramina, one which occupies the anterior and inferior part of the vestibule leads to the superior scala of the cochlea ; the other five situated at the posterior part are the orifices of the posterior part of the labyrinth or the semicircular canals.

The small opening at the posterior and inner part of the vestibule in the sulciform groove leads to the aqueduct of the vestibule.

b. Semicircular canals.

§ 1941. The *semicircular canals* (*canales semi-circulares*) form the posterior and largest part of the labyrinth.

There are three of them which occupy a square space : the *superior* or *anterior*, the *posterior*, *internal* or *inferior*, and the *external*. The first two are perpendicular, the third is horizontal.

When united they form more than half a semicircle. They are much more prominent at one of their extremities than at the other and in the rest of their course, so that they represent in this place a rounded vesicle (*ampulla*). They are not perfectly round externally nor internally, but are slightly flattened and elliptical.

The diameter of their cavity is about half a line.

Their orifices are a little broader than the rest of their course.

The *superior* is oblique from without inward and from before backward. It forms the highest part of the labyrinth, and its two branches are separated the farthest. Its anterior and external opening, which

(1) Ribes, *loc. cit.*, p. 651.

is situated above the fenestra ovalis, forms a considerable vesicle of which we see another trace at its posterior extremity, through which it blends with the superior opening of the internal canal.

The *inferior* is also perpendicular, but its convexity looks backward and its concavity forward. It commences above by a short canal which it has in common with the internal extremity of the superior, and terminates by a vesicular enlargement below and inward in the vestibule.

It is the longest and its branches are nearest each other.

The *external* or *horizontal* arises by a slightly marked vesicular prominence below the external orifice of the superior. Its internal orifice in the vestibule is situated on the outside and below the common opening of the superior and the inferior.

It is the shortest and also the broadest of the three semicircular canals.

The reunion which occurs between the superior and inferior canal diminishes the number of the openings of the semicircular canals to five instead of six.

c. Cochlea.

§ 1942. The *cochlea*(1) forms the anterior and most complex part of the labyrinth. It presents to a certain extent the repetition of the semicircular canals, and its figure perfectly resembles that of the shell-fish whose name it bears.

It is a grooved canal which gradually diminishes from its origin to its extremity, and thus it finally becomes very narrow. It turns around a central and perpendicular portion termed the *axis* (*modiolus*), which gradually becomes thinner. It thus describes two turns and a half.

The first turn is much larger than the rest, which it envelops ; the others however project much beyond it.

§ 1943. A horizontal plate of bone, which arises from the inner part of the cochlea and which is termed the *spiral septum* (*lamina spiralis*), divides it into two canals situated one above the other and termed the *scalæ*.

The lower face of the *spiral septum* presents grooves which look towards the axis. Its upper face is the smoothest.

It is formed of two laminæ, a superior and an inferior.

(1) G. Brendel, *De auditu in apice cochleæ*, *Program. I. II.*, Gottingen, 1747.—J. G. Zinn, *Observationes de vasis subtilioribus oculi et cochlea auris internæ*, Gottingen, 1753.—J. G. Ilg, *Einige anatomische Bemerkungen, enthaltend eine Berichtigung der zeitigen Lehre vom Bau der Schnecke des menschlichen Gehörorgans, nebst einer anatomischen Beschreibung und Abbildung eines durch ausserordentliche knochenwucherung sehr merkwürdigen menschlichen Schädels*, Prague, 1821.

The *inferior lamina* is much broader than the superior, and terminates backward and outward in the fenestra rotunda in the tympanum. This has been termed the *scala of the tympanum* (*scala tympani*). It is separated from the cavity of the tympanum by a membrane which presents a depression on the side of this cavity which is termed the *secondary tympanum* (*tympanum secundarium*).

The *superior scala* is much narrower than the inferior. It terminates at the anterior opening of the vestibule. Thence it is termed the *scala of the vestibule* (*scala vestibuli*).

The cochlea however does not continue separated the entire length of this cavity, and the spiral septum terminates near the middle of the second turn in a pointed hook termed the *hook of the cochlea* (*hamulus cochleæ*).

By uniting in this manner, the two canals of the cochlea give rise to a tunnel-like cavity, the *infundibulum* (*scyphus*), the base of which is turned upward and the summit downward towards the cupola of the cochlea.

This conical cavity forms the most prominent part of the cochlea.

The *axis*(1) which turns on itself is hollow like the scalæ. A larger canal passes longitudinally through it from its base to its summit. It also presents numerous small openings, the diameter of which gradually diminishes from its base to its summit. These openings lead to small canals which terminate on the spinal lamina.(2)

(1) Rosenthal, *Sur la structure de l'axe du limaçon dans l'oreille de l'homme ;* in the *Journal complém. du Dict. des sc. méd.*, vol. xvi., p. 180.

(2) Anatomists have hitherto considered the axis of the cochlea as a small column formed by a very thin osseous lamina, through which a canal passes from the base to the summit, which is perforated by numerous small foramina. It is asserted that it terminates at the second turn of the cochlea, at the top of which it appears on leaving this place as a tunnel-form layer of bone, the summit of which is the termination of the axis, and the upper extremity of which looks towards the summit of the cochlea and is covered by a plate of bone. Hence are distinguished the cavity of the axis and that of the infundibulum. There is also admitted in the latter a thin column around which the spiral septum turns from the second curve, and which terminates in a small osseous plate curved like a hook. Ilg describes the structure of this axis differently. He states that the spiral channels of the cochlea do not turn around a special nucleus of bone ; hence he does not admit an axis, but asserts that it is the inner and concave wall of the spiral canal which forms the species of column around which this canal turns, and that we perceive in it the form of a cylinder on opening the first and second turn of the cochlea. The column is very thick in the first turn where it is a line and a half in diameter, but very thin in the second where its diameter does not exceed half a line. As the internal wall of the spiral canal forms what is termed the axis in the first two curves, so likewise it produces something similar in the third. But this pillar of the third turn has not the form of a cylinder ; it is composed only of a very thin and twisted osseous plate, which arises from the summit of the cylindrical column and extends to the cupola of the cochlea, where it is attached. The loose edge of this plate, which exists all the length of the imaginary axis of the cochlea, from the termination of the cylindrical column to the top of this cavity, is smooth, rounded, and generally a little concave in the direction of its length. Sometimes also it represents a small column which goes directly to the summit of the cochlea. The axis of the column is perforated by a small canal, and this column is filled to the second turn by an osseous cellular mass, the cellules of which communicate with numerous small foramina grooved along the parietes of the column, and into which open some small canals which proceed between the two layers of the septum or spiral lamina. Rosenthal has since modified and rectified the

d. Aqueducts.

§ 1944. The *aqueducts* (*aquæductus*, *diverticula*,)(1) of the labyrinth are short, narrow canals, which are directed from above downward through the substance of the petrous process of the temporal bone, and which enlarge a little in their course. There are two, the *aqueduct of the vestibule*, and the *aqueduct of the cochlea.*

The *aqueduct of the vestibule* (*aquæductus vestibuli*) begins by a very small opening in the inner wall of the vestibule before the common opening of the two perpendicular semicircular canals in the sulciform groove of the vestibule, which is in fact their internal orifice. It first goes a short distance from without inward and a little from below upward in the centre of the petrous process, then from above downward, insensibly enlarges on leaving this curve, and after proceeding about four lines terminates a little behind the centre of the inner face of the petrous process of the temporal bone near the fossa intended for the gulf of the internal jugular vein, with which it always communicates by a slight groove.

The *aqueduct of the cochlea* (*aquæductus cochlea*) commences by a wider opening in the tympanitic scala of the cochlea directly before the fenestra rotunda, descends from before backward, enlarges in this course, and terminates by a triangular opening at about the centre of the inferior edge of the petrous process of the temporal bone.

By these two aqueducts the membranous labyrinth communicates externally,(2) and forms culs-de-sac between the bone and the dura-mater.

description of Ilg. It follows from his researches, that from the summit of the pillar of the first two turns a layer proceeds in a semicircle to the external wall, and terminates by a loose and semilunar edge, which ascends to the infundibulum. The last turn is open on the side of this edge, by which the lamina turned opposite the pillar terminates, and the uniform extremity of the spiral lamina which is reflected around the same edge projects in the turn in question; the two laminæ terminate in this place, or rather blend in this small rounded cavity. The crook turning around the edge of the lamina of the axis in the place where this lamina separates from the centre of the pillar, is like the extremity of the latter, separated from the infundibulum. The edges of the spiral lamina and of that of the pillar are fitted to each other, cross so that their faces are turned from the side of the external wall of the cochlea, and as the latter inclines a little towards the centre of the pillar, they form in some measure a broad tunnel-like edge for the canal grooved in the first two turns of the column to emerge. It follows then from Rosenthal's description: 1st, that, as Scarpa and some other anatomists have asserted, the base of the infundibulum is situated on the summit of the cochlea and its summit in that of the pillar, but it does not extend so deeply as they assert, for it terminates below the last semiturn and is loose below the cupola of the cochlea, and there is no extended lamina of the column which unites with its covering; 2d, that Ilg is mistaken in saying that the axis extends to the centre of the cochlea, to its roof, and that it does not form a tunnel-like edge, and is attached to the summit of the cochlea by a rounded point closed at its extremity. F. T.

(1) D. Cotugno, *De aquæductibus auris humanæ internæ anatomica dissertatio*, Naples, 1761.—P. F. Meckel, *De labyrinthi auris contentis*, Strasburg, 1777.—Ribes, *loc. cit.*, p. 713.

(2) The opinion that the aqueducts establish the communication between the labyrinth and the exterior was admitted by Cotugno, who, thinking that the internal

They also serve for the passage of the arteries which enter the labyrinth and the veins which come from it and the lymphatics, the absorbent action of which prevents the abnormal accumulation of serum in this cavity. The veins, and perhaps some of the lymphatics also, empty into the internal jugular vein. This explains why mercury and other fluids pass from the labyrinth into this vein through the aqueducts, after distending the sacs of the membranous labyrinth.

ear is always exactly filled with serum, had been obliged to explain how this liquid can be moved by the compression exercised upon it by the base of the stapes to suppose the existence of derivative canals, which allow it to escape in part, and to leave a certain space between it and the parietes of the ventricle. The observations of Brugnone and of Ribes, which we shall mention hereafter, overturn all this theory. These anatomists consider the pretended aqueducts only as passages for the arteries and veins. In regard to that of the vestibule, Ribes has discovered that at about the centre of the posterior face of the petrous portion of the temporal bone, where it begins as an uneven and undulating layer, it goes forward, upward, and outward, proceeds first on the inside of the posterior semicircular canal, next between the posterior wall of the vestibule and the superior semicircular canal, curves and penetrates into the concavity formed by this canal, thence goes backward and outward, and is distributed in the spungy tissue of the posterior part of the labyrinth. This duct is at first very broad, and it contracts much in its course upward. It generally gives off in its course other smaller ducts, at each of which it becomes smaller, and among which Ribes has found some which opened into the inner part of the vestibule, others into the posterior semicircular canal, but only in three pieces, for in all others there was no duct from the aqueduct proceeding either within the vestibule or to any other point within the labyrinth. Besides this aqueduct does not exist in the full grown fetus nor even some time after birth. It is designed to contain the blood-vessels which ramify in all the spongy tissue surrounding the labyrinth, and sometimes enter into the vestibule. Ribes asserts that the aqueduct of the cochlea arises at the base of a small depression situated about the centre of the lower edge of the petrous portion of the temporal bone, ascends obliquely to the lower part of the internal auditory passage, passes under the labyrinth, goes horizontally backward and outward, and terminates not in the internal scala of the cochlea, as is stated, but in the canal of the fenestra rotunda below the membrane which closes its opening. As this passage proceeds towards the tympanum it gives rise to numerous branches. It lodges the vessels which are distributed under the labyrinth in the spungy tissue of the petrous portion of the temporal bone and within the tympanum. Thus the two pretended aqueducts belong to the class of vascular canals described in a note on the osseous system. But there are others beside them observed in the petrous process. Ribes mentions three others: 1st, one which arises at about the centre of the posterior base of the petrous process near its upper edge and two lines from the internal auditory passage, goes backward and outward, passes under the anterior semicircular canal, opens directly under the curve of the superior semicircular canal, where it receives the pretended aqueduct of the vestibule, with which it then goes into the spungy substance of the posterior part of the petrous process and in the mastoid cellules, lined by a prolongation of the dura-mater: 2d, another which arises near the centre of the anterior face near the upper edge of the petrous portion, and goes behind the superior semicircular canal: 3d, another which arises at the bottom of the longitudinal fissure which indicates the union of the petrous process with the squamous portion of the temporal bone, and through which pass some vessels which are distributed in the mastoid cells and the membrane of the tympanum. These details may seem minute, but they are of the highest importance, since they contribute to destroy an anatomical error on which rests a part of the theory by which physiologists still explain the philosophy of hearing.

F. T.

II. MEMBRANOUS LABYRINTH.

§ 1945. The *membranous labyrinth*(1) is inclosed in the osseous labyrinth, and corresponds perfectly to its form, although it is much smaller.

It is formed of a thin and whitish membrane, differing entirely from that which covers the inner face of the osseous labyrinth in the early periods of fetal existence. Its external face adheres to the inner face of the bony labyrinth by a loose cellular tissue. It contains in its cavity a fluid called the *serum* of the *membranous labyrinth* or the *lymph of Cotugno*, (*aquula labyrinthi membranacei*).(2) Numerous vessels are distributed in its external face.

The upper and posterior part of the osseous vestibule is occupied by a rounded and oblong membranous sac in which the membranous semicircular canals open, which enlarge also in the parts which correspond to the enlargements of the osseous canals. Before this sac we find one which is rounded, perfectly closed, and consequently entirely separate from the membranous labyrinth, which is smaller, situated partly in the semicircular fossa, and also filled with a serous fluid. These two sacs are attached to the osseous labyrinth by their posterior wall. The anterior, which looks toward the anterior wall of this latter and the fenestra ovalis, is loose and surrounded by the serum of the osseous labyrinth. The semicircular canals are arranged precisely like the osseous semicircular canals.

The membranous cochlea is formed by a fibro-cartilaginous layer, the *membranous spiral lamina*, which is adapted to the external and loose edge of the osseous spiral lamina, and which becoming softer and thinner on the outside is attached by its external edge to the outer side of the osseous cochlea. This lamina is longer than the osseous, for it extends to the summit of the cochlea. In this part of its course it is loose on its inner edge, while the external is attached as in every other part. It terminates in a prominence.

(1) Scarpa, *loc. cit.*—Brugnone, *Observations anatomico-physiologiques sur le labyrinthe de l'oreille;* in the *Mémoires de Turin*, 1805–1808, p. 167–176.

(2) Ribes (*loc. cit.*, p. 207) remarks that there are many adults in whom this humor fills the labyrinth, but there are many in whom it is partially empty, and who nevertheless always hear perfectly. He concludes, from these remarks, that the labyrinth is not constantly filled by serum, and that then there is in fact a space doubtless occupied by an äeriform fluid; but this space, he adds, does not always exist equally in all the cavities of the labyrinth. Sometimes, in fact, we find little of this humor in the semicircular canals, and much in the vestibule and the cochlea; and sometimes the semicircular canals are full, while the other cavities contain but little. Finally he thinks that these changes depend only on the situation in which the cadaver is held. These observations fully confirm those of Brugnone (*Mém. de Turin*, vol. xvi., p. 167), who also thinks that there is almost always serum in all the cavities of the labyrinth, but that this liquid does not exactly fill them in the natural state, because spaces exist in ice removed from them, although liquids acquire more volume by congelation. F. T.

III. AUDITORY NERVE.

§ 1946. We have already mentioned the origin of the auditory nerve and its course to the internal auditory passage, accompanied by the facial nerve. On entering this canal the auditory nerve divides into several branches, which enter the labyrinth, and the progress of which is indicated by the arrangement of the bones.

In fact the internal auditory passage(1) presents at the base of its cavity forward, in the place where the internal and perforated plate of the axis of the cochlea is situated, a crest, the direction of which is from before backward; it is at first slightly sensible, but is very marked in the adult, which divides it into two halves, a superior and an inferior, which is larger. The first belongs entirely to the facial nerve, while the other belongs to it only in a small portion of its anterior part, so that we may say that the superior groove receives the facial nerve, and the inferior the auditory nerve. The first is divided by a longitudinal prominence into two halves, an anterior, the commencement of the Fallopian canal, and a posterior, in which the superior branch of the auditory nerve is situated.

§ 1947. The auditory nerve is distributed to the membranous labyrinth.(2) Its first branches go to the semicircular canals and the vestibule. The first, the largest, passes through the depression behind the origin of the Fallopian canal, and arrives at the sac of the superior semicircular canal; the second goes to the oval depression of the vestibule; the third, still smaller, arrives at the sac of the posterior semicircular canal.

When the first branch has arrived thus far it divides into two twigs, which separate like a fan; one of them goes to the larger or common sac of the semicircular canals, while the other belongs to those of the superior and the external canal.

All these twigs are evidently fibrous and interlace on the outer face of the sacs, but when examined on their inner face they appear to be a formless mucus. They do not extend over the whole vestibule and the semicircular canals, but remain very distinct upon the surface of the sacs.

The nerve then goes forward in the axis of the cochlea, follows exactly the curves of the cavity, and gives off numerous filaments which go inward through the openings in its axis.

The first filaments given off are the largest; the others gradually diminish, and are nearer together.

Finally the nerve terminates at the summit of the axis by a considerable filament much larger than the others, and which enters the openings in the axis.

(1) Ribes, *loc. cit.*, p. 660.
(2) Ribes, ibid. p. 665.

The most internal of these filaments pass through the openings in the curves of the pillar, enter into the canals which terminate there, arrive on the spiral lamina, form an extremely minute plexus along its two faces, and terminate on the membranous spiral lamina, where they are entirely exposed.

Scarpa(1) asserts that they proceed only between the two plates of the spiral lamina; but they in fact cover also the outside of the superior and inferior faces of this layer,(2) and those seen in this place, particularly those on the lower face, are even the largest. Some fewer and much smaller filaments pass through the foramina in the spires of the cochlea near the pillar, and go not into the spiral lamina, but to that portion of the membranous cochlea which forms its external wall. All anastomose together on the outside of the cochlea.

The nervous filaments which enter the cochlea are, like the preceding, white, opaque, and evidently fibrous near their origin; but their latter expansions are semitransparent, more gray, and similar to mucus.

§ 1948. The changes which are communicated to the cerebrum by the auditory nerve and excite there the sensation of sounds, take place in the expansions of this nerve in the membranous labyrinth. These changes are doubtless caused by the compression which the serum in the labyrinth exercises on the ramifications of the nerves, and this pressure is necessarily the consequence of a change in the state of the parts on the outside of the labyrinth, especially in the little bones of the ear and their muscles. In fact, according as the base of the stapes is more or less deeply, and partially or wholly imbedded in the fenestra ovalis, it compresses the serum within it in different degrees, and presses upon different parts of the labyrinth. The external ear and the membrane of the tympanum principally serve to receive the undulations of sound and to strengthen them, which is effected by the tympanum and the mastoid cells. In regard to the little bones of the ear, independent of the use assigned them, the malleus certainly modifies the degree of tension of the membrane of the tympanum, serving to diminish it in loud and to increase it in weak sounds. The Eustachian tubes serve to evacuate the fluids secreted in the tympanum and to admit the air, to balance that acting on the outside of the membrane of the tympanum. They concur also directly to hearing, for they also lead into the tympanum the undulations of sound, which, reflected by the walls of this cavity, fall principally on the membrane of the fenestra rotunda, called for this reason the *accessory tympanum*.(3)

(1) *De org. aud. et olf.*, p. 55–56, § xi.
(2) Monro, *On the ear*, p. 197–199, vol. iii–iv.
(3) Savart has concluded from his important researches on the mechanism of hearing: 1st, that the communication of the vibrations by the air seems to take place, at least for small distances, according to the same laws as those for solid bodies; 2d, that it is not necessary to suppose a special mechanism to cause the membrane of the tympanum to vibrate continually in unison with the bodies which act

ARTICLE THIRD.

DIFFERENCES IN THE EAR DEPENDENT ON DEVELOPMENT.

I. EXTERNAL EAR.

§ 1949. The external part of the organ of hearing does not begin to appear till towards the end of the second month of pregnancy. It first resembles a slightly perceptible eminence formed like an elongated triangle, the base of which looks upward, the summit downward, and which is directly continuous with the lower part of the side of the head, and in the middle of which is a triangular longitudinal fissure which becomes narrower and deeper from above downward. The prominence which surrounds the median depression soon rises to its posterior part, and becomes thinner in this place. It projects above the surface of the side of the head, and slightly shows the median fossa. At the same time, or soon after, the anterior part of the prominence is divided by a transverse fissure which arises from its posterior part into two halves, of which the inferior is the antitragus and the superior the commencement of the helix. At the same time this anterior part of the external ear also rises and the posterior enlarges, but is not re-

upon it, and that it is always in the conditions fit to be influenced by any number of vibrations; 3d, that its tension probably does not vary, except to increase or diminish the extent of these variations, as Bichat had asserted, but always supposing, as Meckel still admits, the contrary of what results from these experiments, that is, by imagining that the membrane is loose in loud and tense in feeble sounds; 4th, that the vibrations of the membrane extend to the labyrinth unchanged by means of the little bones; 5th, that the little bones also serve to modify the extent of the vibrations of the parts in the labyrinth; 6th, finally that the tympanum probably serves to contain an air the physical properties of which are constant. Itard asserts that the membrane of the tympanum does not perform any motion which is visible or denoted by a bristle situated in the centre; but the more delicate experiments of Savart do not allow us to doubt these motions. When we saw the temporal bone on the level of the external face of the membrane, and cover this with sand, we can perceive that the grains move slightly when we bring a disque which is vibrating, parallel to the membrane and near the surface, although its slight extent and especially its form do not allow us to establish there any nodal line. Itard states that the function of the little bones, are to allow us to hear low tones. J. F. St. Hilaire thinks that they are of but little use, and are only indications of the respiratory apparatus, the operculum, developed in fishes. The justice of this second proposition, which we shall not examine here, would not necessarily involve that of the first, although not contradicted by experience. The direct participation of the Eustachian tube in hearing, which was asserted in the commencement of the last century, and afterwards brought forward by Bressa, is evidently erroneous. It has been perfectly refuted by Cotugno and Itard. If it was correct, we ought, as Rudolphi asserts, hear our own voice when speaking loudly after stopping the ears: but this is not true. Itard has very ingeniously compared the Eustachian tube to a hole without which the air in a military drum would not vibrate; but he is mistaken in saying that it seems only to renew the air in the tympanum. This is undoubtedly its principal function, but it also serves to excrete the mucus and the condensed perspiration constantly secreted by the mucous membrane of this cavity. F. T.

moved farther from the side of the head. The anthelix and the tragus are developed also very early at the third month. The anthelix is at first more prominent than it is subsequently, because the posterior edge of the ear rises but slightly or not at all. The lobule appears last.

The external ear is much smaller in proportion to the head, the younger the fetus is.

Its cartilage begins to appear at the third month; but it is developed slowly, for towards the end of pregnancy it is not as yet so extensive under the skin as in full grown individuals.

The cartilaginous portion of the auditory passage, like the external ear, is at first proportionally much smaller than subsequently.

The long portion of this passage begins to form some time after birth by the enlargement of the cavity of the tympanum. Its ossification is singular in this respect, that it generally begins much sooner in the external part of the canal, where it unites to the cartilaginous portion, than in the middle region of its lower part.

The prolongation of the external cutaneous system, around which this passage is situated, already exists very early in the fetus, and it is not then even proportionally much shorter than in the adult, but it has another form and another direction. As the direction of the tympanum is then much more oblique from without inward than it is afterward, the upper part of its circumference at first does not exist; the inferior alone is developed, and forms on the outside and at the bottom of the tympanum, a large sac, which is much more ample in proportion to its length than it is afterward, descends also more perpendicularly, and is situated below the membrane of the tympanum, so as really to form its upper wall.

The skin of the bony portion of the auditory passage is softer and thicker in the fetus than in the adult.

II. INTERNAL EAR.

§ 1950. 1st. The tympanum in the early periods of life is proportionally shorter and narrower than at a later season, particularly, because the mastoid process is very small, and its cells are not yet formed. It is filled in the fetus with a thick gelatinous fluid, and it communicates with the mouth more directly the younger the fetus is, since the Eustachian tube is shorter and broader in the same proportion. The cartilaginous portion of this tube, until the middle of pregnancy, is simply membranous, and even in the full grown fetus the bony portion is at most separated within the canal by a layer of bone, which formation continues most generally through life, so that the septum rarely extends also to the outer side.

The tympanum, and with it the membrane, are much larger in proportion either to the external ear or to the whole head and body, the younger the fetus is, and even until the fifth month of pregnancy, both

are larger than the external ear. Besides, as the osseous portion of the auditory passage is not yet developed, the membrane of the tympanum is much nearer the surface in the early periods of existence than subsequently, so that the upper part directly touches the entrance of the cartilaginous portion of the auditory passage, and consequently is almost exposed in this point, a very curious circumstance from its analogy with reptiles. Both also differ at first in direction, which is more horizontal, because at this period the membrane of the tympanum is more oblique from above downward and from without inward.

2d. The small bones of the ear differ from all other bones of the body by their uncommonly early appearance and development.

They are visible and even uncommonly large in proportion, at the commencement of the third month of pregnancy, although at this period they are still entirely cartilaginous, and we cannot well distinguish the stapes from the incus. Thus, for instance, the malleus is about three lines high in the fetus of four months, so that the body being then four inches from the vertex to the coccyx, its length is to that of the whole body as 1 : 16, while in the adult, where is to four lines long, and where the distance between the vertex and the coccyx is two feet and a half, the proportion is only as 1 : 90. The small bones of the ear are as large in the full grown fetus as in the adult.

They begin to ossify also very early, even before the end of the third month. Cassebohm asserts(1) that the stapes and incus ossify sooner than the malleus, that the osseous nucleus of the incus is seen first in its anterior branch, and that of the stapes in the head, whence it extends along the two branches to the base, which, with the lower region of the anterior branch, ossifies the last. In the malleus, ossification commences in the head and anterior process. Our observations do not exactly agree with those of Cassebohm. It is true that the anterior branch of the incus ossifies before the posterior : we have always found it perfectly ossified, while the latter was entirely cartilaginous, but the ossification of the malleus commences at the same time as that of the incus, and the stapes is still entirely cartilaginous, when it has advanced considerably in the other two bones. The place where it begins in the stapes is not well determined : it is sometimes in the lower part of the posterior branch, and sometimes in the base, but never, according to our observations, in the head.

These bones differ very much in their forms. The incus changes the least. The branches of the stapes seem at first not to be separated from each other, which deserves to be noticed on account of the analogy resulting from it with the formation of this bone in the cetaceous animals, and with that of the inner part of the single bone of the ear in birds and reptiles. It is certain that even where these two branches are detached from each other, the opening between them and the base is proportionally much smaller than at subsequent periods, although,

(1) *Loc. cit.*, p. 56.

however, its form is then less oblong. This narrowness of the foramen, which is evidently an approximation to its entire deficiency, and the union of all the parts of the stapes in one, depend principally on the greater thickness of its branches.

But of all the bones of the ear, the malleus changes the most during its development. Perhaps no other bone can be compared with it in this respect.

The most remarkable difference is the existence of a right cartilaginous process, formed like a very elongated cone, which is also very long and very thick in proportion to the rest of the bone. This process arises from the anterior side of its head, leaves the tympanum between the petrous process of the temporal bone and the ring of the tympanum, is fitted directly to the inner face of the lower jaw, and extends to the anterior extremity of this bone, where it sometimes, perhaps even always, unites with that of the opposite side. This cartilage never ossifies, although in the commencement it forms most of the mass of the bone; it disappears at the eighth month. The anterior process of the malleus corresponds with it, it is true, to a certain extent, in respect to its position: but we also perceive that in the fetus, where the two parts are distinct from each other, the cartilage is situated above the anterior process. We may then at most admit that this latter makes part of it, and that they are separated very early. This cartilage is very curious, because fishes, reptiles, and birds, present a similar one, which extends from the posterior to the anterior portion of the lower jaw. In these animals it rests on a small bone placed on the inner face of the posterior part of the lower maxillary bone, and we may consider it as a rudiment of the malleus, which does not exist in them.

3d. The membranous labyrinth exists long before the osseous labyrinth. We have found it at three months perfectly developed in the cartilaginous mass, which afterwards ossifies. Even in the early periods of life it is more distinct, and formed of firmer and more solid membranes than at subsequent periods. It is composed at first of two very distinct membranes, an external and an internal, which are simply inclosed in each other, but there is no continuity between them.

The internal is white, transparent, thinner, but firmer and more elastic than the external. The latter does not adhere to the cartilage, as afterward it is not attached to the bone which is developed at the expense of this latter.

The inner face of the external membrane is smooth, and the external is corrugated. It gradually disappears, so that at seven months we cannot trace it. Before entirely disappearing it gradually becomes thinner. The internal becomes proportionally narrower but firmer: it seems to be attached more intimately to the inner face of the cartilage which surrounds it, in the early periods of existence than subsequently.

As yet we have been unable to ascertain if there is not a period when the membranous labyrinth is uncovered in the skull, at least in part, and where its structure is more simple than it is afterward. At three months it is entirely surrounded by a mass of cartilage, and is as complex in its structure as at a more advanced period of life. We only remark, that like the cartilage which envelops it, it is at first more compressed from without inward, and proportionally higher, which undoubtedly depends, at least in part, on the greater development of the encephalon.

At four months we find the membranous cochlea as complex as it is in the adult, while afterward its circumference seems to be formed only by the membranous labyrinth; it is then constituted by a very thick membrane, which makes a part of this latter. We have as yet been unable to obtain any sufficient data in regard to its form before the fourth month of pregnancy.

The secondary tympanum and the fenestra rotunda are at first situated more externally and parallel to the membrane of the tympanum. They afterwards go backward, which depends principally on the development of bone in their circumference.

4th. When we study the development of the osseous labyrinth, we must distinguish the formation of the osseous substance of the petrous process of the temporal bone from that of its own. The first commences before the second, and follows the usual mode of ossification, that is, it takes place by the development of a loose, soft, and plexiform tissue, in the homogeneous mass of cartilage previously existing, which gradually extends from before backward. The circumference of the fenestra rotunda ossifies first towards the end of the third month, which is curious as an analogy between this opening and the tympanum. Ossification begins at the upper part, then extends to the lower, and when it has thus formed a ring, it goes forward. At the same time there is developed a special osseous nucleus, which is entirely distinct from the preceding, at the outer extremity of the superior perpendicular semicanal: next there appears a third small scale at about the centre of the internal perpendicular semicanal. At the same time ossification proceeds rapidly backward and downward from the point first formed, and gives rise to the floor of the labyrinth. The second nucleus enlarges more quickly perhaps than the first, so that the superior perpendicular semicanal is soon entirely ossified, excepting only its lower and concave face. At the same time, ossification, commencing at its internal extremity, advances on the internal face of the petrous process, circumscribes the internal auditory foramen, enters within it, and forms the floor of the cochlea.

The horizontal semicircular canal begins to ossify at the fifth month. At this time the piece of bone which forms the superior perpendicular canal extends backward, downward, and outward, around the membranous horizontal canal. At least we have been unable to discover a special nucleus for this canal, which seems to ossify by the extension of the first two nuclei, the edges of which finally unite.

The formation of the interior of the cochlea belongs almost wholly to the osseous labyrinth. The cartilage and then the osseous substance of the petrous process, do not participate in it except by a narrow prolongation sent by this latter into the cavity containing the membranous and then the osseous labyrinth, the spires of which it slightly separates.

The loose edge of this projecting lamina is turned outward. It extends from the upper part of the fenestra rotunda and the outside of the cochlea, to the summit of this latter, across its cavities, and thus divides it anteriorly, but very imperfectly, into an external and an internal cavity. This lamina is broader at first than it is subsequently. Besides, the internal face of the cochlea is entirely smooth, and this part of the internal ear presents at this period the greatest analogy with the cochlea of birds: at a later period, after the third month, as the cochlea enlarges from without inward, the lamina in question becomes narrower, and at the same time slight prominences are developed, which separate externally the two and half turns of the cochlea from each other, and make part of it.

The osseous labyrinth is at first entirely separated from the osseous mass of the petrous process which surrounds it, and which is developed before it. It is, however, always applied to it. Its surface then is entirely smooth. The inner face of the osseous mass of the petrous process is also smooth to a certain extent, although more corrugated than that of the labyrinth. The two surfaces soon blend together, but they can be entirely separated in children, and the smooth polished surface of the labyrinth can be demonstrated; but they afterward become inseparable. The line of demarkation is very evident in every part, particularly in the cochlea, where it is perceived that the prolongations described above are perfectly distinct from the canal formed by the membranous and osseous labyrinths.

Thus the osseous labyrinth is developed independent of the osseous substance of the petrous portion. As the external membrane of the membranous labyrinth disappears at the period of its formation, it is not improbable that it changes into osseous substance, or at least that this substance transudes through its external face. In fact, this membrane does not exist for some time with the osseous labyrinth, and may always be easily separated from it: but we are satisfied, from numerous observations, that as the osseous labyrinth is developed around it, it becomes denser, firmer, dryer, and in a measure horny: hence we have been induced to believe that the two modes of formation coexist, that is, that the membrane secretes first the labyrinth, then that an analogous substance being deposited with it, it unites with the layer it had first formed, and becomes its internal layer. The formation of the osseous labyrinth would thus resemble that of the teeth.(1)

(1) Ribes has asserted that in the fetus the serum of the labyrinth is reddish, bloody, and exactly fills it. As the infant grows older, it becomes clear, limpid, and less in quantity, and the ear becomes more sensible to sounds. F. T.

ARTICLE FOURTH.

ORGAN OF HEARING IN THE ABNORMAL STATE.

§ 1951. As the organ of hearing is very complex, it presents very numerous and very different anomalies(1) in respect to their essence; by these the ear is unusually hard or soft, or is entirely deficient.

§ 1952. The *deviations of formation* are here, as in every other part, the most interesting in a physiological point of view.

As in all other parts of the body, they are more or less characterized by a retarded development,(2) and are also more or less repetitions of what is observed in animals inferior to man.

Sometimes the development of the whole ear is arrested.(3)

I. EXTERNAL EAR.

§ 1953. 1st. *Deviations of form in regard to quantity.* The *entire absence* of the external ear, of which we possess some instances, depends on the permanence of a state which marks the early periods of fetal existence.

The anomaly varies a little less from perfect development when the ear is closed, which can exist in different degrees; these lead imperceptibly to the normal formation by the shortness and narrowness of the external auditory passage.

The absence of the lobule, or its adhesion with the skin of the head, is the least deviation from the normal state. This state also exists regularly at a certain period of the formation of the fetus.

We may consider the frequent enormous enlargement of the ears as an anomaly of an entirely different character.

2d. *Deviations of formation in regard to quality.* These are the turning of the ear on the orifice of the external auditory passage, which more or less closes this canal.(4)

II. INTERNAL EAR.

A. TYMPANUM.

§ 1954. 1st. *Deviations of formation in respect to quantity.* Sometimes the tympanum is not sufficiently large, and is even closed on the

(1) Besides the works of Duvernoy, Wildberg, and Saunders, already mentioned, which treat also of the diseases of the ear, consult, J. A Rivinus, *De auditus vitiis*, Leipsic, 1717.—J. M. G. Itard, *Traité des maladies de l'oreille et de l'audition*, Paris, 1821.—C. F. A. Eschke, *Diss. de auditus vitiis*, Berlin, 1819.

(2) See on this subject our *Handbuch der pathologischen Anatomie*, vol. i. p. 400-406.

(3) Rœderer, *Descripl. fœtus parasil.;* in *Comm. soc. Gœit.*, vol. iv.

(4) Walter, *Fetthautgeschwülste*, Landshut, 1814. p. 33.

outside as in fishes. Sometimes one or more of the little bones of the ear are deficient, or they are too small.(1) Sometimes they are unusually large, thus preserving the distinctive characters of the fetus. They are rarely more numerous than usual. When supernumerary bones exist, they are always very small. They occur particularly between the malleus and incus, and also in the neck of the stapes.

2d. *Deviations of formation in regard to quality.* The bones of the ear are sometimes formed after a different type, and then are more or less similar to those of certain animals.

Thus Comparetti(2) observed in a man, that not only the two stapedes were very small, but also formed by a single branch, with a small base closing the fenestra ovalis, which was very narrow.(3)

B. LABYRINTH.

When the labyrinth is very imperfectly developed, there is only a single cavity closed externally, which is not divided into the vestibule, cochlea, and semicircular canals, and which does not communicate with the tympanum.(4) This form resembles that of the organ of hearing in the crustacea and the cephalopoda. Perhaps it is normal also in the early periods of the existence of the human fetus.

When the development is more advanced, the cochlea describes fewer turns than usual,(5) even as in reptiles and birds, it appears as a sac-like prolongation, which is not curved on itself. From our preceding remarks, this anomaly should be considered as a continuance in the fetal state.

The labyrinth is sometimes ossified imperfectly, whence a portion of the membranous labyrinth is exposed.(6)

(1) Bernard, *Sur un vice d'organisation de l'oreille externe;* in the *Journ. de physiol. expér.*, vol. iv. p. 167.

(2) *Loc. cit.*, p. 24.

(3) We find the malleus sometimes larger, sometimes shorter, sometimes with an enlarged head or process. The incus has been observed sometimes narrower, sometimes broader, and sometimes with its long branch more or less arched. Rudolphi has described and figured (*Diss. sis. observationes osteologicas*, Berlin, 1812, tab. i. fig. 15.) a stapes, of which the branch alone communicated with the base, the other being loose, and forming with the preceding an obtuse angle. Lœsecke seems to have observed a similar case (*Obs. anat. chirurg.*, Berlin, 1754, p. 15.) . Tiedemann has described a stapes found in a newly born infant, which presented neither branches nor opening. It resembled a small pyramid, the base of which represented the plane surface, and from whence a piece of bone arose, slightly depressed, which was articulated with the long branch of the incus by a rounded process. He has also seen in an adult the two branches of the stapes completely united by a layer of bone, so that there is a slight depression, but no opening between them (*Sur quelques variations dans la forme de l'etrier chez l'homme;* in the *Journ. complém. des sc. méd.*, vol. viii. p. 83. F. T.

(4) Roderer, *loc. cit.*—Meckel, *Handbuch der pathologischen Anatomie*, vol. i. p. 406.

(5) Mondini, *Anat. surdi nati;* in the *Comm. Bonon.*, vol. viii.—Meckel, *loc. cit.* vol. i. p. 403.

(6) Mondini, *loc. cit.*

C. AUDITORY NERVE.

Sometimes in deaf and dumb people the auditory nerve is smaller(1) by half than it is generally.(2)

§ 1955. The *accidental* or *consecutive deviations of formation* result from an external lesion, which is purely mechanical, or an alteration in texture. Sometimes in hydrocephalus the two external bones of the ear are pushed outward and detached from the stapes, and sometimes even this is unconnected with the fenestra ovalis.(3)

§ 1956. The *alterations of texture* in the organ of hearing are principally *inflammation* and its consequences, among which we must first mention *adhesion* and *suppuration*, which frequently affect the external and the internal ear. The buccal orifice of the Eustachian tube is frequently obliterated after scarlatina, or the tympanum and the bones are destroyed by ulceration. The entire or partial destruction of the membrane of the tympanum and very probably also the anomalies in the tumors of the labyrinth, which are thickened,(4) solidified, and changed into a hard body(5) after long affections of the internal ear,(6) belong to this class.

The new formations developed in the organ of hearing are:

1st. *Accidental ossification*, by which the bones of the ear adhere to each other, and obstruct the fenestra rotunda,(7) in which case we also find the bones, particularly the stapes, twice as large as they are generally: the stapes also is fused with the fenestra ovalis,(8) and forms osseous concretions(9) in the membrane of the tympanum.(10)

(1) Haighton, *Mem. of the med. society*, vol. iii. p. 1.

(2) This fact has been observed several times, among others by Sylvius, Hoffman, and Arenda. Itard also has seen it: but he thinks that the wasting of the auditory nerve is more frequently the effect than the cause of deafness (*loc. cit.*, vol. i. p. 392.) F. T.

(3) Blumenbach, *Geschichte der Knochen*, p. 140.

(4) Haighton, *loc. cit.*—Cline, in Saunders, *loc. cit.*, p. 88.

(5) Secon this subject an important memoir on the physiological relations, by G. F. St. Hilaire, *Sur la nature, la formation et les usages des pierres qu'on trouve dans les cellules auditives des poissons;* in the *Mém. du Muséum*, 1824.

(6) Itard has seen one case (*loc. cit.*, vol. i, p. 395) where the fluid of the labyrinth was deficient.

(7) Cotugno, *loc. cit.*, § 72, p. 61.

(8) Valsalva, *De aure humanâ*, cap. ii. § x.

(9) Cassebohm, vol. iii., p. 33.—Loeseeke, *Obs. anat.*, p. 25.—Koehler, *Beschreibung der Loderischen Präparate*, p. 148.

(10) Ribes (*loc. cit.*, p. 654) has found the membrane of the fenestra rotunda ossified in a man completely deaf, and destroyed in several subjects, some of whom had not completely lost the power of hearing. This latter circumstance deserves to be remarked, since complete deafness does not result from injuries of the membrane of the tympanum, which is so analogous to that of the fenestra rotunda. According to Pinel's observations, it would seem that deafness depends on an alteration in the texture of the mucous membrane of the internal ear rather than on any other cause, although he seems to attribute it to the diminution of the fluid in the labyrinth, which in this case is only a consequence of inflammation. (*Recherches sur les causes de la surdité chez les viellards;* in the *Archiv. gén. de méd.*, vol. vi., p. 247.) F. T.

2d. The formation of accidental cartilages and fibro-cartilages sometimes observed under the form of tumors which adhere to the auditory nerve.(1)

Among the entirely abnormal formations we must arrange the *fungous* tumors and the *polypi*, which are developed principally in the mucous membrane of the auditory passage.

CHAPTER II.

ORGAN OF SIGHT.

§ 1957. The *organ of sight* (*oculus*)(2) occupies the upper part of the front of the face, and is situated on the right and left, on the sides and above the root of the nose in the orbit and circumference of this cavity. We distinguish the *eye* or the *globeof the eye* (*bulbus oculi*) with the muscles which move it and the parts which protect it.

ARTICLE FIRST.

PARTS WHICH PROTECT THE EYE.

§ 1958. The parts which protect the eye(3) comprise two folds of skin, called the *eyelids*, very thick hairs, called the *eyebrows*, and the *lachrymal passages.*

(1) Sandifort, *Obs. anat. pathol.*, book i. c. 9.

(2) Fabricius d'Aquapendente, *De visione, voce el audilu*, Venice, 1606.—V. F. Plemp, *Ophthalmographia*, s. *tractatio de oculo*, Louvain, 1648.—G. Briggs, *Ophthalmographia, seu oculi ejusque partium descriptio anatomica*, London, 1685.—J. Taylor, *Nouveau traitè d'anatomie du globe de l'œil, avec l'usage de ses différentes parties, et de celles qui lui sont contiguës*, Paris, 1738.—A. Bertrandi, *Diss. II. de hepate et oculo*, Turin, 1748.—J. G. Zinn, *Descriptio anatomica oculi humani*, Gottingen, 1753.—G. Porterfield, *Treatise on the eyes, the manner and phenomena of vision*, Edinburgh, 1759.—M. Horrebow, *De oculo humano ejusque morbis*, Copenhagen, 1792.—A. Monro, *Miscellaneous observations on the structure and the function of the eyes ;* in his *Treatise on the brain, the eye, and the ear*, Edinburgh, 1797. —S. T. Sœmmerring, in Demours, *Traité des maladies des yeux*, vol. iv.—J. G. G. Voit, *Oculi humani anatomia et pathologia*, Nuremberg, 1810.—C. H. T. Schreger, *Versuch einer vergleichenden Anatomie des Auges*, Leipsic, 1818.—D. G. Sœmmerring, *De oculorum humani animaliumque sectione horizontali*, Gottingen, 1818. —J. A. Hegar, *Diss. de oculi partibus quibusdam*, Gottingen, 1818.—C. F. Simonson, *Anatomico-physiologicus tractatus de oculo*, Copenhagen, 1820.

(3) Rosenmuller, *Organorum lacrymalium partiumque oculi externarum descriptio*, Leipsic, 1797.

I. EYELIDS.

§ 1959. The *eyelids* (*palpebræ*) are perpendicular folds situated before the anterior orifice of the orbit, which they close more or less perfectly. They are distinguished into *upper* and *lower*. They blend together in the *great* or *internal* angle, and the *small* or *external angle* of the eye (*canthi oculi, internus et externus*), and are separated from each other their entire breadth by a *transverse fissure* (*fissura palpebrarum*).

The superior is much greater than the inferior; a flat ligament formed of transverse fibres several lines long, leaves the great angle of the eye and goes inward between the fibres of the internal portion of the orbicularis palpebrarum muscle; its internal extremity is broader than the external, and is attached to the upper part of the nasal process of the superior maxillary bone. This is the *palpebral ligament* (*lig. palpebrarum*).

The *eyelids* are composed of two layers of skin, one external and the other internal, of cartilage and muscular fibres. They rarely or never contain fat.

The exterior layer of skin makes a part of the external cutaneous system. It differs from the rest of the skin only in being very thin and destitute of hair.

It is continuous on the edge of the eyelids, which is nearly a line broad, with the internal layer which belongs to the internal cutaneous system, that is, to the mucous membranes. This layer is also thin, reddish, and moist.

It is termed the *conjunctiva*. It lines the whole extent of the inner face of the eyelids, is reflected on itself in the parts where these movable folds are attached to the rest of the skin, and is called the *tunica adnata*, is fitted to the anterior part of the *sclerotica*, from which it may always be easily separated, and which it covers to the circumference of the transparent cornea. At least it is not possible strictly to demonstrate that it extends also on the anterior face of this last membrane, for if in certain morbid affections a layer rises on the anterior face of of the cornea, this circumstance authorizes us to think, but does not prove, that this layer in question is a prolongation of the conjunctiva. Admitting that this passes really on the cornea, and that it blends with the external pellicle of this membrane without any marks of separation, it does not follow that it possesses in this place the characters of a serous membrane,(1) for the anterior face of the transparent cornea belongs rather to the class of the mucous membranes.(2) Walther has already demonstrated(3) that it is wrong to exclude the conjunctiva

(1) P. F. Walther, *Abhandlungen aus dem Gebiete der praktischen Med.*, Landshut, 1810, p. 413.
(2) Wardrop, *Morbid anatomy of the eye*, Edinburgh, 1818, p. 14.
(3) *Loc. cit.*, p. 414.

entirely from among the last membranes. The adhesions(1) between its two opposite faces which have been brought forward to separate it from the other mucous membranes, and which have been used to a certain extent to class it among the serous membranes, are rare and accidental, and supervene probably after suppuration, in which case even the mucous membranes contract adhesions.

A. EYELASHES.

§ 1960. The anterior part of the edges of the eyelids presents three or four irregular ranges of short, straight and arched hairs, which gradually become larger from the two angles of the eye to the centre, and which are termed the *eyelashes* (*cilia*).(2) Those of the upper lid are more numerous and stronger than those of the lower. The former are arched from above downward, the latter from below upward. When the lids close they intercross and form from their curve a broad ridge.

B. MEIBOMIAN GLANDS.

§ 1961. Farther back and nearer the posterior limit of the edge of the eyelids, at about its centre, is a series of openings regularly arranged, which are also larger in the upper than in the lower eyelid, and which do not occupy the entire breadth of these movable lids. These openings lead to the *glands of Meibomius*, or the *sebaceous glands of the eyelids* (*Gl. Meibomianæ*, s. *palpebrarum sebaceæ*), small, very elongated, narrow, tortuous bursæ, which terminate in sacs generally single, but sometimes divided at their base into several compartments, which are situated perpendicularly below the conjunctiva, between it and the tarsal cartilages. These glands are filled with a thick, yellowish viscous substance, called *lema*, which accumulates around the eyelashes during sleep, and which is easily distinguished by its color from the red conjunctiva.

C. PALPEBRAL CARTILAGES.

§ 1962. Each eyelid contains between the two layers of skin and near its loose edge an oblong cartilage, called the *tarsus*, which determines its form. These cartilages extend much farther from without inward than from above downward, and they are very thin from before backward. They are much thicker at their loose and straight edge than on their convex portion, which looks to the base of the eyelids;

(1) A. Schmidt, in the *Ophthalmologische Bibliothek.*, vol. iii., part 1, p. 18.
(2) H. Meibom, *De vasis palpebrarum novis Epist.*, Helmstadt, 1666.

they extend on the inside only to the lachrymal puncta, and terminate on the outside also a little before the commissure of the two eyelids. Their convex edge and their internal and external extremity becomes at the two angles of the eye a very dense cellular tissue, which is called the *tarsal ligament* (*lig. tarsi, internum et externum*); this unites them to the external and internal edge of the anterior opening of the orbit.

D. MUSCLES OF THE EYELIDS.

§ 1963. The eyelids have two muscles which act in opposite directions, the *orbicularis palpebrarum* and the *levator palpebræ superioris* muscles. The first is common to the two; the second belongs to the upper eyelid only. The lower eyelid has no special muscle.

A. ORBICULARIS PALPEBRARUM MUSCLE.

§ 1964. The *orbicularis palpebrarum* muscle, *naso-palpébral*, Ch. (*M. sphincter palpebrarum*, s. *oculi*), is thin, membranous and circular, although a little elongated. It occupies the upper and anterior part of the face and the lower and anterior part of the skull. Consequently it is not by any means confined solely in the eyelids.

Its internal part is the slightest but the thickest. After leaving this point it extends considerably upward, downward and outward.

It is attached above and below to the palpebral ligament, so that it may be said to leave the inner angle of the eye and to return to it.

Besides this origin, several other fasciculi pass before and behind the palpebral ligament, whence it follows that a portion of this muscle is formed by uninterrupted circular fibres.

The orbicularis muscle arises above by short tendinous fibres from the upper extremity of the nasal process of the superior maxillary bone, from the os unguis, and the lower and anterior part of the nasal and orbitar portions of the frontal bone.

It arises below by similar fibres from the lower part of the inner edge, and from the inner part of the lower edge of the orbit, which are formed by the ascending process and by the body of the superior maxillary bone.

Its fibres separate especially in its lower part, and fasciculi are detached from its outer part, some of which go the cellular substance and others enter the zygomaticus minor and the levator labii superioris muscles.

The internal part of this muscle which is contained in the eyelids, where it is situated directly below the external cutaneous layer, is much less extensive than the external. Its fibres are straighter, thinner and paler than those of the latter, with which it is always un-

interruptedly continuous, although it has been considered a special muscle, called the *ciliaris* muscle.

B. LEVATOR PALPEBRÆ SUPERIORIS MUSCLE.

§ 1965. The *levator palpebræ superioris* muscle, *orbito-palpébral*, Ch., is very long, thin and triangular. It arises by a short tendon at the base of the orbit from the periosteum which lines the upper part of the optic foramen, and blends in this place with the tendons of the rectus internus and rectus superior muscles. It gradually becomes broader and thinner, advances directly under the orbitar plate, covering first the inner and then the whole of the rectus superior muscle. It finally becomes a very thin tendinous expansion, often scarcely perceptible, part of which is attached to the upper edge of the superior palpebral cartilage, while the other passes between the orbicularis palpebrarum muscle and this cartilage, and extends to its lower edge where it is inserted.

It raises the upper eyelid.

E. THIRD EYELID AND CARUNCULA LACHRYMALIS.

§ 1966. Beside the upper and lower eyelids there is also in the great angle of the eye a third which is much smaller and imperfect.

The two palpebral commissures differ in form. The external is more pointed than the internal. The latter resembles a small and narrow prolongation of the palpebral fissure towards the nose, the separation of which with the rest of the fissure is marked very evidently by the lachrymal puncta, and which terminates inward in a rounded edge.

The third eyelid is found in this space.

It has the form of a triangle, the summit of which looks inward and the loose edge outward; this last is semicircular. It is formed by a fold of the conjunctiva by a small palpebral cartilage situated near its loose edge, and by a considerable number of sebaceous glands united in a rounded or slightly triangular mass, between which are small, straight and very fine hairs analogous to the eyelashes.

The sebaceous glands are situated entirely inward, and project particularly on its anterior face.

They are called the *caruncula lachrymalis*. The external and loose part of the third eyelid which passes much farther forward than the caruncula, has been termed the *semilunar fold* (*plica semi-lunaris*).

This part then really possesses all the constituent parts of an eyelid. It differs from the other eyelids by its smallness and in the deficiency of an external layer of skin and of muscular fibres. It is in fact a rudiment of the third eyelid which exists in most vertebrated animals. In fact the perpendicular eyelid of these last differs from it only by its

greater size. When we descend in the animal scale we see that its development is always in an inverse ratio with that of the horizontal eyelids, and that finally it entirely replaces them.

II. EYEBROWS.

§ 1967. The *eyebrows* (*supercilia*) are short, strong, compact hairs, which gradually increase in size from within outward, and which are arranged in several superimposed striæ. These hairs form a little above the upper eyelid an arch, the convexity of which looks upward. The two arches they describe blend more or less at their inner part.

We may consider this part of the face as the commencement of the upper eyelid.

The eyebrows are moved each by a special muscle, the *corrugator supercilii.*

The *corrugator supercilii* muscle (*fronto sourcilier*, Ch.) is thick and large. It covers the inner part of the upper edge of the orbit. It is covered at its origin by the upper internal part of the orbicularis palpebrarum muscle, and by the internal and inferior part of the frontalis muscle; it arises by very short tendinous fibres from the frontal bone, below the inner part of the supraciliary ridge. Its fibres are oblique. Its direction is outward, and it gradually becomes thinner. It is so blended, particularly in its external part, with the upper portion of the orbicularis palpebrarum muscle, which entirely covers it, and which may be considered as a deeper layer of this latter muscle.

It wrinkles the eyebrows, and the skin of the forehead perpendicularly.

III. LACHRYMAL PASSAGES.

§ 1968. The *lachrymal organs* or *passages* (*organa lachrymalia*, s. *viæ lachrymales*), form a special apparatus, the function of which is to secrete and excrete a transparent liquid termed the *tears* (*lachrymæ*).(1)

This apparatus includes the *lachrymal gland* and its excretory ducts, the *lachrymal puncta*, and the *lachrymal passages*, the *lachrymal sac*, and the *nasal canal*. We may annex to a certain extent the conjunctiva, as it is uninterruptedly continuous with the excretory passages, the gland, and the lachrymal puncta, and as, strictly speaking, it is only a considerable dilatation of the excretory portion of the lachrymal organ.

A. LACHRYMAL GLAND.

§ 1969. Only one *lachrymal gland* is commonly admitted:(2) there are, however, two, generally arranged so that one is superior, the other

(1) Berzelius, *Djurkemi*, vol. ii. p. 219–221.

(2) N. Stenon, *De glandulis oculorum nonisque eorum vasis observationes anatomicæ quibus veri lacrymarum fontes detegunlur*; in the *Obs. anat.*, Leyden, 1662.—

inferior. Both belong to the list of conglomerate glands. They are situated behind the upper eyelid, directly below the orbitar plate.

The *superior lachrymal gland* (*Gl. lachrymalis superior*, s. *innominata Galeni*), is much larger than the other. It occupies the lachrymal depression of the frontal bone. It is triangular, and flattened from above downward. The *inferior* (*Gl. congregatæ Monroi*)(1) touches at its posterior extremity, the anterior part of the preceding, and extends to the external part of the upper edge of the cartilage of the upper eyelid. Its lobules are smaller and more remote from each other, than those of the upper.

Six or seven very small canals arise from these two glands, and go from behind forward, from without inward, and from above downward, and open at the side of each other from without inward, on the inner face of the upper eyelid, near the external angle of the eye.

B. LACHRYMAL PUNCTA AND LACHRYMAL PASSAGES.

§ 1970. The upper and the lower eyelids present each, at the part where the inner angle commences, and where the orifices of the Meibomian glands terminate, an opening, the direction of which is rather more backward, and which may easily be distinguished from those of the palpebral glands and the lids, as its diameter is much larger, and as it is supported by a conical prominence. These two openings are termed the *lachrymal puncta* (*P. l. superius et inferius*). The direction of the upper is downward, and that of the lower is upward. The latter is most generally larger than the other.

These puncta are the orifices of the *lachrymal passages* (*canaliculi lachrymales*, s. *cornua limacum*), which extend to the lachrymal sac.

The lachrymal passages proceed directly on the edges of the eyelids, covered posteriorly by the internal cutaneous layer of these lids, and anteriorly by the orbicularis muscle, with which they are so intimately connected, that they are detached from its fibres with great difficulty.

The superior first ascends a little outward, in which direction also the inferior descends. In this part of their course they are very narrow. Then after slightly projecting, the superior goes inward and downward, and the inferior upward, and both converge very much. Arrived at the inner angle of the eye, they pass under the palpebral ligament, and open into the anterior and external part of the lachrymal sac, one directly above the other, but by two distinct orifices. They form within this cavity a small rounded prominence.

A whitish and smooth mucous membrane forms their parietes.

A. Monro, *On the lachrymal glands and ducts*; in the *Anatomical and physiological observations*, Edinburgh, 1738, p. 770. tab. ii.—J. J. Beaux, *Physiologie de la glande lachrymale*, Paris, 1821.

(1) *Loc. cit.*, p. 77.

C. LACHRYMAL SAC.

§ 1971. The *lachrymal sac* (*saccus lachrymalis*) differs much in its breadth, direction, and structure, from the lachrymal passages.

It is infinitely broader than they, but it contracts a little from above downward.

It is covered anteriorly by the inner part of the orbicularis palpebrarum muscle, and is situated above in the lachrymal groove, along which it extends upward into the lachrymal passages by a small cul-de-sac, and downward into the *nasal canal*. It descends first from within outward and from behind forward, then, on arriving at the nasal canal its direction is from before backward. In its course its diameter gradually diminishes. It opens into the anterior part of the lower meatus of the nasal fossæ, by an opening which is oblique from above downward and from within outward, and which is provided with a small valve.

It is formed of three superimposed membranes.

The external is whitish, and is evidently fibrous, and also serves as a periosteum to the bones which receive the lachrymal sac; but it is also very apparent on the anterior side of the upper part of the sac which lodges the lachrymal groove.

The middle is thin and cellular: it corresponds to the cellular tunic of the mucous membranes. The internal is thick, rough, spungy, verrucous, and of a deep red. It always secretes an abundant mucus, which oozes through the rounded and oblong orifices of small glands arranged very compactly.

This internal membrane is evidently the continuation of that of the nasal fossæ, while that which forms the lachrymal passages is continuous with the conjunctiva, so that it establishes the limit between the eye and the nose.(1)

(1) Horner has discovered a new muscle of the eye, the following description of it is extracted from his *Treatise on General and Special Anatomy*, vol. ii. p. 408.

"The tensor tarsi is a small muscle on the orbital face of the lachrymal sac. It arises from the posterior superior part of the os unguis, just in advance of the vertical suture between the os planum and the os unguis. Having advanced three lines, it bifurcates; one bifurcation is inserted along the upper lachrymal duct, and terminates at its punctum, or near it; and the lower bifurcation has the same relation to the lower lachrymal duct. The base of the caruncula lachrymalis is placed in the angle of the bifurcation. The superior and the inferior margins of the muscle touch the corresponding fibres of the orbicularis palpebrarum, where the latter is connected with the margin of the internal canthus of the eye, but may be readily distinguished by their horizontal course. The nasal face of this muscle adheres very closely to that portion of the sac which it covers, and also to the lachrymal ducts. The lachrymal sac rises about a line above its superior margin, and extends in the orbit four lines below its inferior margin. The orbital face of the muscle is covered by a lamina of cellular membrane, and between this lamina and the ball of the eye are placed the valvula semilunaris, and a considerable quantity of adipose matter.

As the bifurcated extremities of the muscle follow the course of the ducts, they are covered by the tunica conjunctiva. When this muscle is examined from behind, the eyelids being in situ, it becomes obvious that it is concave on its orbital surface, and consequently convex on the nasal; that the muscle is an oblong body, half an inch in length, and about three lines wide, bifurcated at one end; and that it

ARTICLE SECOND.

GLOBE OF THE EYE.

§ 1972. The *globe of the eye* (*bulbus oculi*),(1) often termed simply the eye, is formed like an almost regular globe. In the adult its diameter is about an inch: its length, however, exceeds its breadth and its height. It occupies the anterior part of the cavity of the orbit, but passes a little before it. It is surrounded in every part by an abundance of fat, and also by the muscles which move it, and which contribute with the optic nerve, and numerous blood-vessels, to retain it in place.

It is formed by several superimposed membranes and the humors contained by them. In respect to the form and the texture of the membranes, and that of the nature of the humors, we may divide it into two parts, a posterior and an anterior, the first of which is more extensive than the other.

arises much deeper from the orbit than any acknowledged origin of the orbicularis. The superior fork, however, has a few of its fibres blended with the ciliaris.

In regard to the use of this muscle. Its attachment to the posterior face of the sac is such, that it draws the orbital parietes of the sac away from the nasal, and dilates the sac, from the nasal face of the latter being fixed to the bones. As this muscle has a cylindrical concavity on its orbital side, it is evident that when it contracts the fibres become straight, or nearly so, like the fibres of the diaphragm, and the cavity of the sac is enlarged after the same manner as the cavity of the thorax. A tendency to a vacuum being thus produced by it, the valves or folds of the internal membrane of the sac, permit the vacuum to be filled more readily through the puncta than from the nose; and the puncta being continually bathed in the tears of the lacus lachrymalis, both in the waking and in the sleeping state, the tears are constantly propelled through them by atmospheric pressure. The evacuation of the sac is no doubt accomplished by its own elasticity, and by the contraction of the orbicularis; probably in a chief degree by the latter, because in persons who have epiphora, or a tendency to obstruction in the nasal duct, the accumulation of tears and matter principally take place at night, when the action of the orbicularis is suspended by sleep. For these reasons we should argue, that this little muscle is active all the time, both night and day. To Dr. Physick I am indebted for suggesting another use for this muscle; that of keeping the lids in contact with the ball of the eye. Some persons possess unusual voluntary power of this muscle, of which I have seen two examples; one in a lady; another in a gentleman, a student of medicine. In each instance the individual could shorten so much the internal angle of the eyelids, as to conceal it, along with the puncta, in the internal canthus of the orbit."

Trasmondi, on the contrary, thinks that it acts on the lachrymal sac and passages, that it compresses the caruncula lachrymalis so as to favor the excretion of the humor formed by its crypts, and that it relaxes or also tenses the membrane, so as to increase or diminish the base of the lachrymal sac, and to force the tears into the nasal canal. (*Notice sur la découverte de deux nerfs de l'œil humain;* in the *Mélanges de chirurgie élrangère*, Geneva, 1824, p. 415). Gery (*Ibid.* p. 453) does not agree with his fellow-countryman, and thinks with Horner, that this muscle serves to adapt the lids to the globe of the eye, and to direct the tears into the lachrymal sac. F. T.

(1) C. A. Rudolphi, *Diss. de oculi quibusdam parlibus*, Gripswald, 1801.—Id. *Ueber einige Theile des Auges* in his *Anatomisch-physiologische Untersuchungen*, vol. i. p. 1–30.—Dœllinger, *Illustratio ichnographica oculi humani*, Wurtzburg, 1817.—Edwards, *Sur la structure de l'œil:* in the *Bulletin de la soc. philom.*, 1814, p. 21.—E. Home and F. Bauer, *Observations microscopiques sur la structure de l'œil;* in *Phil. trans.*, 1822, p. 76, and in *Archiv. génér. de méd.*, vol. ii. p. 151.

The most external membrane is the *cornea*, the posterior part of which is the *opaque cornea* or the *sclerotica*, and the anterior, the *transparent cornea*. Next comes the middle membrane, the *choroid*, the anterior part of which is termed the *iris*, and below this is a third, the *retina*, which is a prolongation or expansion of the optic nerve.

I. MEMBRANES OF THE EYE.

A. EXTERNAL MEMBRANES OF THE EYE.

§ 1973. The *external* membranes of the globe of the eye are much firmer and thicker than the others. Its form is determined principally by them.

A. SCLEROTICA.

§ 1974. The *sclerotica*, the *opaque cornea*, or the *albugineous membrane of the eye* (*tunica sclerotica*, s. *albuginea*, s. *cornea opaca*), covers the posterior part of the eye, and occupies about five sixths of its circumference. It presents posteriorly, a little nearer its inner side than its centre, a round foramen, or at least it is much thinner there than in its other parts, and there presents numerous small cribriform openings, through which the fasciculi of the optic nerve communicate with the retina. It is terminated anteriorly by a broad rounded opening which recieves the transparent cornea.

As it belongs to the class of fibrous membranes it is white, brilliant, fibrous, very elastic and solid. We may forcibly divide it into several layers: but these are united by intermediate filaments.

The two faces are smooth. Numerous blood-vessels, the trunks of the twigs distributed to the inner part of the eye, intimately adhere to the external; some of these vessels perforate it posteriorly, others more anteriorly at about its centre. They all proceed within its substance a greater or less distance, which is proportional to their own volume.

Smaller openings in its posterior part give passage to the ciliary nerves, which penetrate from without inward between it and the choroid membrane.

The sclerotica is not equally thick in every part. It generally diminishes much from behind forward. Posteriorly it is about a line thick, and about one half of a line at the edge of the transparent cornea.

The membrane is thinner in the points which correspond to the attachment of the tendons of the recti muscles of the eye, than between these insertions.

In the place where the optic nerve communicates with the globe of the eye, it unites very intimately with the envelop given to this nerve by the dura-mater. Although it is eight or ten times thicker, and also

firmer than this envelop, we may however consider them as identical, since they do not differ essentially in regard to texture.

§ 1975. Among the superimposed layers of the sclerotica, one may be detached more or less easily from the others, and with greater facility in the early periods of life, than in the adult. This very thin layer is a prolongation, not of the pia-mater as has been supposed since Zinn's time,(1) but of the envelop sent by the arachnoid membrane to the optic nerve, and with which it is evidently continuous. It forms a small bursa projecting inward, around the cribriform plate, through which the optic nerve enters the eye, and is reflected from the circumference of this layer on the inner face of the sclerotica, with which it unites intimately, proceeding with it to its anterior edge.

There is then between this layer and the sclerotica, exactly the same relation as between the dura-mater and the arachnoid membrane within the skull and the vertebral column, or, employing a more general comparison, as between the hard substances, as the cartilages and the fibrous organs, covered with serous membranes and these membranes.

The inner face of this internal layer of the sclerotica, is rather intimately united to the choroid membrane by a loose cellular tissue, and also by the nerves and vessels which pass through the external capsule of the eye. We may, however, especially some days after death, separate and remove the sclerotica, without injuring the choroid membrane.

B. TRANSPARENT CORNEA.

§ 1976. The *transparent cornea* (*tunica cornea*, s. *cornea pellucida*)(2) which surrounds the anterior part of the eye, differs from the sclerotica in its texture so much, that it is impossible to apply the same term to these two membranes.

It represents a segment of a sphere which is a little smaller than that of which the sclerotica is the figure, so that it is more convex and projects slightly on the surface of the latter.

It is always a little thicker than the sclerotica, and its thickness is generally uniform, except at its circumference, where it gradually becomes much thinner, but only in a slight extent. Sometimes, however, it is a little thicker in the centre than on the edge. Its posterior face always describes a concavity which corresponds exactly to the convexity of its anterior face.

The conjunctiva extends towards the upper edge and the lower edge of its external face for about half a line, so that this external face is not perfectly round, but slightly elliptical. The upper face, on the

(1) Zinn, *loc. cit.*, p. 11

(2) B. D. Manchart, *Corneæ oculi tunicæ examen anatomico-physiologicum*, Tubingen, 1743.—Hoffbauer, *Diss. de cornea ejusque morbis*, Berlin, 1820.—M. J. Chelius, *Ueber die durchsichtige Hornhaut des Auges*, Carlsruhe, 1818.

contrary, is entirely round. It terminates by a circular depression or groove which receives a prominent edge, situated on the limit between the ciliary ligament and the iris.

It always becomes much thinner and is serrated at its point of union with the sclerotica.

The two membranes are united in three different ways.

Sometimes the anterior face gradually diminishes, so that the transparent cornea is partly covered by the sclerotica.

Sometimes the two faces gradually become thinner, and the cornea is inserted in a channel grooved on the anterior edge of the sclerotica.

Finally sometimes the internal face insensibly disappears, and the cornea rests a little on the anterior edge of the sclerotica.

The first is the most common and the last the rarest arrangement.

§ 1977. The transparent cornea is formed of several layers having between them a limpid fluid which are separated more easily than those of the sclerotica, and which are united by a loose cellular tissue.

This fluid transudes after death. Its evaporation causes in part the opacity and collapse of the cornea, which then occur.

The posterior face of the cornea is covered by a thin, pellucid, homogeneous and slightly extensible membrane, which tears evenly when forcibly extended and is easily detached from it by a slight maceration or by boiling.(1) This membrane is attached to the edge of the cornea, and does not proceed at least sensibly on the iris. It has been termed the *membrane of the aqueous humor* (*mem. humoris aquei*) this term is inappropriate, as it does not seem to secrete the aqueous humor.*(2)

B. CHOROID MEMBRANE AND IRIS.

§ 1978. Directly below the external tunic of the globe of the eye is another membrane of about the same extent and also composed of two halves differing in their organization. The posterior is termed the *choroid* membrane, and the anterior, which is much smaller, the *iris*.

(1) B. Duddell, *Treatise on the diseases of the horny coat in the eye*, London, 1729.—J. Descemet, *An sola lens crystallina cataractæ sedes*, Paris, 1758.—Id. in the *Mém. des sav. étrangers*, book i.—Demours, *Lettre à M. Petit*, Paris, 1767.—The details of the quarrel between Descemet and Demours, in regard to the discovery of this membrane, are given in the *Journ. de méd.*, 1769, 1770, 1771.

* Professor Schlemm of Berlin, asserts that the cornea is well supplied with nerves: "They arise from the ciliary nerves which divide behind the ciliary ligament into a superficial and a deep-seated order of filaments. The latter are larger and more numerous, and are distributed to the iris; the superficial however enter the sclerotica on a level with the ciliary ligament, from whence they extend forward to enter the groove of the edge of the cornea which is united with the corresponding border of the sclerotica, and traverse the posterior part of the cornea until they become lost by their extreme tensity upon that membrane." (*Am. Journ. of the Med. Sciences*, Nov., 1830, p. 211.)

(2) S. Sawrey in 1807 claimed the discovery of this membrane, which had been vaguely imagined by Duddell, and which in fact had been discovered by Demours or Descemet. (*An account of a newly discovered membrane in the human eye*, London, 1807.) F. T.

A. CHOROID MEMBRANE.

§ 1979. The *choroid membrane* (*tunica vasculosa*, s. *choroidea*)(1) corresponds to the sclerotica. It extends from the anterior edge of this membrane to the entrance of the optic nerve for which it presents a rounded opening and to which it is directly united, particularly along the course of the nerves and vessels, in its whole extent by rather a loose cellular tissue. The union between the two membranes is only interrupted here and there by the ciliary nerves and the long ciliary arteries, which proceed between them from behind forward.

The inner face of the choroid membrane is not attached to the retina, although they are in direct contact.

§ 1980. Near the anterior extremity of the choroid membrane the mucous tissue becomes much thicker in the outer face of the membrane, and forms a whitish ring about one line broad, called the *ciliary ligament*, the *commissure of the choroid membrane*, Ch. (*L. ciliare*, *orbiculus ciliaris*, *circulus ciliaris*, *plexus ciliaris*). This ring attaches the choroid membrane to the sclerotica more firmly than in the rest of its extent; but it is united to the sclerotica much less intimately than to the choroid membrane, which is thinner in the part corresponding to it, so that the latter can be easily detached from the opaque cornea, while this is not the case with the ciliary ligament, which may consequently be considered as forming part of it.

The internal circumference of the ciliary ligament is bounded by a narrow but very evident white projection, which fits exactly into a groove on the circumference of the inner face of the transparent cornea.

Before this ring is the *iris*, which is intimately united with it.

B. CILIARY BODY.

§ 1981. The inner face of the choroid membrane is singularly changed in this place, where it forms the *ciliary body* (*corona ciliaris*, s. *orbiculus ciliaris*, *corpus ciliare*, *tunica ciliaris*).(2) In fact on leaving the external edge of the ciliary ligament it forms, inward and for the breadth of about a line and a half, numerous small folds, whence come a great number of slightly prominent rays which go from without inward. Another smaller and more internal circle then succeeds, formed by more distinct folds, the inner edge of which is convex and

(1) Ruysch, *Ep. anat.* xiii.—L. Heister, *Diss. de tunicâ choroideâ*, in the *Fasc. diss. med.*, Leyden, 1745.—B. S. Albinus, *De tunicâ Ruyschianâ et choroideâ oculi*; in the *Ann. acad.*, l. vii., cap. iv.

(2) J. G. Zinn, *De ligamentis ciliaribus programma*, Gottingen, 1753.—Doellinger, *Sur les procès ciliares dans l'œil de l'homme*; in the *Nov. acta nat. cur.*, vol. ix., p. 274.

which become more prominent from without inward, and terminate in a rounded edge. These folds, which are termed *ciliary processes* (*processus ciliaris*), are fewer in number although very numerous, as there are about seventy. They are however much more remote from each other than the external. Their anterior extremity is loose. They are attached to the large circumference of the crystaline capsule by the anterior part of their adherent edge. The posterior part of all this region of the choroid membrane adheres very intimately to the external face of the ciliary ligament, for its folds are received into the depressions of this latter, the form of which corresponds exactly to theirs, so that in this part the inner face of the choroid membrane is firmly united to the subjacent parts, and when we attempt to detach it in the recent state the ciliary ligament is generally torn.

§ 1982. The choroid membrane is soft and thin, but its tissue is firm and solid. On removing the coat of the pigment it appears whitish and slightly transparent. It is almost entirely formed by blood-vessels which are very distinct on its two faces, especially on the external.

Some of these vessels are arteries and others veins,(1) but the latter are much more numerous.

§ 1983. The arteries of the choroid membrane, termed the *ciliary* arteries (*A. ciliares*), are principally of two kinds.

The long *ciliary* arteries (*A. ciliares longæ*) are longer and more superficial than the others; there are generally but two, an external and superior and an internal and inferior. These two arteries are situated more or less nearly opposite each other. After passing through the sclerotica at its posterior part they are situated on the anterior part of the choroid membrane, proceed directly from behind forward without sending off any very large branch, and are distributed in the iris. Hence they do not really belong to the choroid membrane.

The *short* or *posterior ciliary* arteries, *uvéales*, Ch. (*A. ciliares breves*, s. *posteriores*), are much smaller but more numerous than the long. There are usually twenty or more of them of different sizes. They perforate the sclerotica more posteriorly and internally than the preceding, nearer the optic nerve, and soon enter the choroid membrane. They there divide into twigs which are given off at acute angles, frequently anastomose together, especially in the anterior part of the choroid membrane, and form forward, behind the external edge of the ciliary body, a circle composed of a very complex network.

The twigs they produce in dividing are parallel, and proceed very closely from behind forward. At the posterior part of the choroid membrane they are situated on its outer face, but towards the centre of the globe of the eye they pass through it and go to its internal face,

(1) J. E. Hebenstreit, *De vasis sanguiferis oculi*, Leipsic, 1742.—J. G. Zinn, *De vasis subtilioribus oculi et cochleæ auris internæ*, Gottingen, 1753.

where consequently they are more distinctly perceptible than in the external.

§ 1984. The veins of the choroid membrane are easily distinguished from the arteries by their course and their larger size.

Their branches are very compact, radiate from before backward and from without inward, form large arches, and divide into twelve or fourteen small twigs which pass through the sclerotica at about the centre of the globe of the eye, proceed a few lines from before backward in this membrane, and reunite in four or five larger trunks which pass out of the eye at its posterior part and enter the ophthalmic veins. Four of these trunks are much larger than the rest, some of which proceeding also from before backward, receive the twigs coming from the iris.

These veins have been termed from their numerous curves the *vasa vorticosa*. They are more superficial than the arteries, and are also more external at the anterior part of the choroid membrane and form its external layer.

Besides these veins there are others, the *long* or *anterior ciliary* veins (*V. ciliares longæ*, s. *anteriores*), which accompany the long ciliary arteries, return from the iris, and receive no considerable ramifications from the choroid membrane.(1)

§ 1985. The blood-vessels and the mucous tissue which supports them are the only organic elements visible in the choroid membrane. Those fibres which are directed from before backward, and are admitted by several anatomists to exist, have never been seen by us, and even the ciliary body seems only a very complex tissue of vessels.

§ 1986. The internal face of the choroid membrane does not appears perfectly smooth to the naked eye, but presents, particularly if the eye be injected, numerous small floating flocculæ which give it a downy appearance; this is much more evident if we use the microscope. These flocculæ are very well developed in the ciliary body. They are mostly formed by a very compact tissue of vessels, particularly in the posterior region of the choroid membrane, the inner face of which is almost entirely covered by them, while they leave it much looser anteriorly.

§ 1987. The internal face of the choroid membrane cannot be considered as a special membrane in man, as we cannot divide it into two layers. Ruysch first asserted this opinion, while his son termed this coat the *tunica Ruyschiana*. It is also incorrect to admit as the *villo-glandular tunic*(2) or the *supra-choroid membrane* (*membrana supra-chorioidea*)(3), another membrane situated on the outside of the choroid, which would be the *second middle tunic* of the eye, or even the *third*,

(1) See the plate of the vessels of the choroid membrane, in Sœmmerring, *Ueber das feinste Gefassnetz der Aderhaut im Augapfel*, 1818.

(2) B. A. Stier, *De tunicâ quadam oculi novissime detectâ*, Halle, 1759.

(3) Montain, in the *Journal de méd.*, vol. lvii.—*Bull. de la soc. méd. d'Emul.*, 1807, p. 330.

by admitting the tunica Ruyschiana, and which has been regarded as belonging to the class of serous membranes.(1)

Finally it is still more incorrect to represent the choroid coat as formed by five superimposed layers,(2) of which the second, third, and fourth form the proper choroid membrane, and the other two the two membranes mentioned.

c. IRIS.

§ 1988. The *iris*(3) is a circular membrane perforated in its centre with a rounded and nearly concentric opening, termed the *pupil*. This opening is a little narrower on its inner side, which looks towards the nose, than in the rest of its course,(4) and its external edge is attached to the anterior edge of the choroid membrane, viz. to the ciliary ligament. Finally, it is entirely loose in the chamber of the eye, where it forms a transverse septum extended from above downward and from right to left, which divides this chamber into two compartments, an *anterior* and a *posterior*, communicating by the opening of the pupil.

The iris forms the posterior wall of the *anterior* chamber of the eye, and the transparent cornea forms its anterior wall. It constitutes, on the contrary, the anterior wall of the *posterior* chamber, the posterior wall of which is formed by the anterior face of the crystaline lens, and the anterior edge of the ciliary body.

The posterior wall of the iris is also termed the *uvea*.

In man it is straight and not convex anteriorly, as has been asserted.(5) It is nearer the anterior face of the crystaline membrane than the posterior face of the transparent cornea.(6) The space on its external face where it is greatest, between it and the crystaline membrane, is not even half a line, but in the centre it is only a quarter of a line. Its centre is about a line distant from the transparent cornea, but its outer edge is much nearer this membrane.

Its extent from without inward varies extremely. It is not only often morbidly dilated to such an extent that the pupil almost entirely disappears, and sometimes contracts so much as to be invisible or nearly so, but also in the normal state it dilates and contracts rapidly under the influence of certain external and internal causes.(7) By carefully

(1) Doellinger, *loc. cit.*, p. 6.

(2) Hovius, *De circulari humorum motu*, Leyden, 1716, p. 29.

(3) Maunoir, *Mémoire sur l'organisation de l'iris, et l'opération de la pupille artificielle*, Paris, 1812.

(4) Winslow, *Observations sur la mécanique des muscles obliques de l'œil, sur l'iris*, &c.; in the *Mém. de Paris*, 1721, p. 463.—Littleton, *Sur les causes d'où dépend la largeur de la pupille;* in Bradley, *Med. and phys. Journal*, vol. xxxvi., p. 89.

(5) Petit, *Mém. sur les yeux gelés, dans lequel on détermine la grandeur des chambres qui renferment l'humeur aqueuse;* in the *Mém. de Paris*, 1725, p. 54.

(6) *Ibid.*, 1726, p. 295 and 408.

(7) J. G. Zinn, *De motu uveæ;* in the *Comm. Gott.*, vol. i.—F. Fontana, *Dei moti dell'iride*, Lucca, 1765.—J. F. Blumenbach, *De oculis leucaethiopum et motu*

examining all the circumstances which belong to these two phenomena we conclude that the active state of the iris is that of dilatation, the passive that of contraction.

§ 1989. This membrane is much thicker in its larger and external than in its internal part, where it seems to be divided obliquely from without inward and from before backward, and terminates there in a thin edge. The most internal part excepted, the iris is three or four times thicker than the choroid membrane.

Its external and internal edges are more deeply colored than the intermediate parts. The darkest part of the membrane is a small portion of the inner surface situated a little on the outer side of the inner edge. This dark place and the portion of the iris between it and the pupil is called the *small* or the *internal circle* (*annulus minor*, s. *internus*). The rest of the membrane is termed the *great* or the *external circle* (*annulus major*, s. *externus*).

The whole of the anterior face of the iris is entirely colored. The posterior is colored only in the portion corresponding to the small circle: all the rest is whitish, but covered with a dark mucus (§ 1997). The anterior face is the seat of the peculiar color of the eyes. It is every where covered by very minute and differently colored flocculæ, which with the streaks of pigment abovementioned on the posterior face are the grounds of the different color of the eyes.

§ 1990. We observe both on the anterior and the posterior face of the iris circular fibres which are slightly undulatory, and longitudinal fibres which radiate from without inward. The first are particularly evident near the outer and inner edge. The others are more distinct on the anterior face; they are larger and more perceptible in the great than in the small circle.

Some of these fibres are whitish and alternate with others less manifestly gray. The first divide frequently at acute angles into a considerable number of small branches, which anastomose on the outer circumference of the small circle, giving rise to arches which are convex forward, and thus form a complex crown from which smaller and closer longitudinal striæ emanate; these radiate in the internal circle to the edge of the pupil.

§ 1991. The iris is soft and spungy.

It is mostly composed of nerves and vessels united by mucous tissue, and very probably also of fibres, the seat of the contraction and dilatation mentioned above (§ 1988).

iridis, Gottingen, 1785.—F. Hildebrandt, *De motu iridis*, Brunswick, 1786.—Doemling, *Ueber die Ursache der Bewegung der Regenbogenhaut;* in Reil, *Archiv. für Physiologie*, vol. v.—Caldani, *Intorno di movimenti dell'iride;* in the *Mem. della soc. ital.*, vol. xiv., pt. 2, p. 101–114.—C. A. F. Kluge, *Diss. de iridis motu*, Erford, 1806.—S. S. Guttentag, *De iridis motu*, Breslau, 1815.—Littleton, *On the causes which influence the size of the pupil;* in the *Lond. med. and phys. journal*, vol. lvi, 1816. p. 89, 265.—E. H. Weber, *Tractatus de motu iridis*, Leipsic, 1821.

§ 1992. The *nerves of the iris* (*N. ciliares*)(1) arise from the first branch of the fifth pair, from the sixth pair and the great sympathetic nerve, are about twenty in number, and perforate the sclerotica a little behind the centre of the great diameter of the eye, pass some lines even in the substance of this membrane, are then situated between it and the outer face of the choroid membrane, adhere but slightly to these two coats, proceed from behind forward without giving off any branch, and arrive at the external edge of the ciliary ligament, directly behind which they generally divide at an acute angle into two branches. These branches go forward on the anterior face of the choroid membrane under the ciliary ligament and arrive at the anterior face of the iris, where they form the whitish and radiating filaments there observed; in the course of these are rounded filaments which are perhaps ganglions.

The ciliary nerves are unusually large in proportion to the iris, and hence this membrane is one of the parts of the body, if not the very part, which possesses the most nerves.

§ 1993. The *vessels* of the iris arise principally from the long or anterior ciliary vessels.

Each of the two *long ciliary* arteries divides below the ciliary ligament into two branches, which go to meet the two corresponding branches of the other arterial trunk, and which by anastomosing with them form on the external edge of the iris a crown slightly convex forward, from which numerous twigs arise; the latter radiate towards the inner edge of the membrane and still bifurcate, communicating here and there by transverse ramuscules. They anastomose together on the outer edge of the internal ring so as to form at the opening of the pupil a more or less concentric circle; from this, new radiating twigs arise and go to the small circumference, but several of them however come directly from the rays of the great external arterial circle.

Besides the arterial twigs, the iris also contains many little veins which enter some into the long ciliary veins and others into the vasa vorticosa. As they cannot be filled except by injecting them through the arteries, or as when injected through the venous trunks, they are filled less perfectly than the arteries, the veins seem fewer and form but small arches.(2)

These vessels are most apparent on the anterior face of the iris, to which they seem but loosely attached.

They certainly carry red blood, since the membrane bleeds when wounded, and their reddish color is very evident in the eyes of albinos, where the pigment continues colorless from a primitive deviation of formation.(3)

§ 1994. Even in the most perfect injections, the iris still seems to be formed of more or less evident yellowish white fibres, which as we

(1) Tiedemann, *Diss. de ganglio ophthalmico et nervis ciliaribus animalium*, Landshut, 1815.
(2) Zinn, *loc. cit.*, p. 94.
(3) Monro, *Ueber den Bau der Fische*, Leipsic, 1787, p. 74.

have already stated, seem to be the seat of the motions executed by this membrane.

Several anatomists, as Drelincourt,(1) Ruysch,(2) and Monro,(3) formally adopt this opinion, or are, like Zinn,(4) very much inclined to it.

They assert that some of the fibres are radiated and others circular: the first extend from the external to the internal circle, where Ruysch thinks that they are even attached by small tendons: the circular form most of the internal circle of the iris.(5) In contracting, the longitudinal fibres dilate the pupil, while the circular contract it.

Beside the circular fibres which are admitted by Monro and Ruysch, we have sometimes observed on the anterior face of the iris, towards its outer edge, some very evident circular fasciculi, corresponding to those discovered in the same place in the eye of the ox by Monro;(6) but neither the anatomy, nor the observation of the vital phenomena of the iris, seem to us to justify the admission of radiating longitudinal fibres.

§ 1996. The iris in man can be divided, but not naturally, into two layers, an anterior or the proper iris, and a posterior or the *uvea*, and these cannot be separated except in small portions. It is also uncertain whether its anterior face be lined by a prolongation of the membrane of Demours; at least it is here also much thinner than on the posterior face of the transparent cornea, and its nature is different.

§ 1997. Opinions vary in regard to the manner in which the iris and choroid membrane are united. Some assert that the iris is a prolongation of the latter; others think that it should be regarded as a distinct membrane.

The arguments in favor of the second opinion are:

1st. The greater thickness of the iris.

2d. Its numerous nerves, while the choroid membrane has none.

3d. The fewer vessels which carry blood to it, which differ in their origin and arrangement from those of the choroid membrane.

4th. The difference between the two membranes in respect to their vital phenomena, since the iris is highly contractile, while the choroid membrane possesses no contractility.

We may also add that the great edge of the iris is easily detached after a maceration, which does not continue long enough to destroy the continuity of the tissue either of this or of the choroid membrane.

(1) *Prælud. anat. Opp. omn.*, p. 195.
(2) *Respons. ad epist. anat.* xiii., *Thes. anat.* ii., p. 13–15.
(3) *Loc. cit.*, p. 110–115.
(4) *Loc. cit.*, p. 91, 95.
(5) Monro (*loc. cit.*, tab. 3).
(6) *Loc. cit.*, tab. 2.

D. PIGMENT.

§ 1997. The two faces of the choroid membrane and the posterior face of the iris or the uvea, in the normal state, are covered with a brownish colored substance, termed the *pigment* (*pigmentum nigrum*).(1) In some parts, particularly on the posterior face of the iris, this pigment can be detached in a greater or less extent as a fine and coherent membrane. In some places, particularly on the inner face of the ciliary body, especially between the processes, and the posterior face of the iris, and generally in the internal regions, it is more abundant, deeper in color, and more attached to the adjacent parts. There is less on the external than on the internal face of the choroid membrane, although that which exists there does not differ essentially from that found in other parts. There is none on the posterior part of the inner face of the choroid membrane around the opening which gives passage to the optic nerve, so that the choroid coat is white in this place.

The pigment is composed of a peculiar mucous substance and of another coloring substance, the first of which connects all the molecules together, so that they have the form of a membrane. In regard to mechanical structure, this coloring substance is composed of globules. These globules are not perfectly black, but only present occasionally small points of a deeper tint. Their form is irregularly round. They are smaller in the ciliary processes, but are arranged in several superimposed layers more uniformly black. In regard to their chemical composition, they contain a considerable quantity of iron and also of carbon, which forms almost half of them, so that of all parts of the body they contain the most of this elementary substance.(2) The iron is the cause of their heaviness but not the source of their color, since the quantity of this metal in the rete mucosum of the skin of the negro is small, and even less than in that of the Caucasian race.(3)

The pigment is essentially so similar to the rete mucosum, that we may admit they are the same, whence it follows that the pigment is not a secreted fluid but a solid tissue, an organic element possessing a special form.

(1) Mondini, *De oculi pigmento*; in the *Comm. Bonon.*, vol. vii., p. 29.—Elsaesser, *De pigmento oculi nigro*, Tubingen, 1800.—L. Gmelin, *Diss, sistens indagationem chimicam pigmenti nigri oculorum taurinorum et vitulinorum, adnexis quibusdam in id animadversionibus physiologicis*, Gottingen, 1812.—F. Mondini, *Sul nero pigmento dell' occhio*; in the *Opuscoli scientifichi di Bologna*, 1818, fasc. vii., p. 15-27.—Berzelius, *Djurkemi*, ii., p. 201.

(2) Berzelius, in the *Med. chir. trans.*, vol. iii., p. 255.—Coli, in Mondini jun., *loc. cit.*, p. 17.

(3) Coli, *loc. cit.*, p. 26.

C. RETINA.

§ 1998. The third distinct membrane of the eye is the *retina*.(1) It is the expansion of the optic nerve, the anterior extremity of which contracts much in passing through the sclerotica, but more gradually and more insensibly at its inner than at its outer part, so that the nerve describes an arch much larger outward than inward.

Before the anterior extremity of the optic nerve the sclerotica presents a surface with numerous foramina, through which the fasciculi of the nerves pass. Beyond this cribiform plate the extremity of the nerve forms a small mammillary prominence, from which the expansion of the retina arises; this terminates forward at the posterior extremity of the ciliary body by a straight edge more or less evidently enlarged, which is unconnected with the crystalline capsule.(2)

§ 1999. The retina is white, thin, homogeneous, and destitute of fibres, equally thick in every part, excepting one small point of its extent posteriorly. It is composed, in a measure, of two layers, an external, which is medullary, and an internal, formed by cellular tissue and vessels. The latter separates the medullary layer from the vitreous body. We cannot however insulate the two layers from each other so as to obtain one alone in the form of a connected and coherent whole, although the internal appears in this form when putrefaction has destroyed the medullary layer. Hence we cannot consider the retina except as formed by the union of two special and distinct membranes; but we really find on its external face a very thin membrane(3) very analogous to the serous membranes, which seems to us

(1) J. H. Moeller, *De tunicâ nerveâ et nervo optico*, Halle, 1749.—B. S. Albinus, *De tunicâ quam vocant retinam;* in the *Annot. acad.*, book iii., cap. xvi., *Ann.* 1756.

(2) Several old anatomists, particularly Winslow, Casscbohm, Ferrein, Licutaud, and Haller, whose arguments have been collected by Zinn (*loc. cit.*, p. 114), and Monro among the moderns (*loc. cit.*, p. 96), have asserted that the retina passes below the ciliary body, and that it extends to the great edge of the crystaline capsule, to which it is attached. But careful dissections have led us to embrace the contrary opinion, which has been supported by Morgagni, Zinn, and some of their predecessors. Monro says that we can prove that the retina extends to the crystaline humor: 1st, by resting the eye on the transparent cornea, and there making a transverse section which includes all the membranes with the vitreous body; 2d, by raising the ciliary body and carefully removing the pigment with a pair of forceps. But in following these two processes we have always recognized that the retina terminates evidently at the posterior extremity of the ciliary body, and we have even found that the layer still partially covered by the pigment, which extends from the hyaloid membrane to the crystaline capsule, was more transparent than the retina. The eyes of the fetus are better than those of the adult to demonstrate that Monro's opinion is false, because in them the retina is more opaque, and the external wall of the canal of Petit is thinner.

(3) Jacob, *Newly discovered membrane in the eye;* in Thomson, *Annals of philosophy*, July, 1818, p. 74; *Phil. trans.*, 1819, p. 300; *Journ. compl. des sc. méd.*, vol. xi., p. 187.—Jacobson, *Mémoire sur une humeur peu connue de l'œil, et sur les maladies auxquelles donnent quelquefois lieu les changemens survenus dans sa sécrétion;* in the *Act. soc. reg. med. Hafn.*, vol. vi.; and *Bull. de la soc. méd. d'Emul.*, September, 1822.—G. Mirault, *Sur une hydropisie particulière au globe de l'œil;* in the *Archiv. gén. de méd.*, vol. ii., p. 48.

to be the seat of the ossifications sometimes occurring between the choroid membrane and the retina.

§ 2000. The retina is extended on the vitreous body, and forms there no fold, except in a small extent of its posterior part, at some distance from the entrance of the optic nerve, and on its outer side.

There in fact the membrane presents, a fold which is directed inward, a *yellow spot*, and a round place, where it is extremely thin.(1)

The direction of this fold is transverse from within outward. It commences at some distance from, or directly at the side of the entrance of the optic nerve by a small point, and is terminated by a blunt extremity. It is generally from a line and a half to two lines long. It is commonly single, but sometimes also it is double. In some subjects it is deficient.(2) Home asserts even that it is never natural, and that its formation depends on the more intimate union in this place between the retina and the hyaloid membrane. But the error of the English anatomist is proved by the facts that the fold is observed even when the connections between the two membranes are unaltered, and that it is much more evident in youth than subsequently.

The retina presents at the same place a yellowish spot of the same size, which is darker in the centre than on the edges. It is generally one line high, and from one and a half to two lines broad. But it has not the same extent and degree of color in every part, although these two peculiarities are not necessarily connected with the sense of vision.

The retina is much thinner in this place than in the rest of its extent, particularly in the centre of the yellow spot, where some admit the existence of a foramen, while others, and according to our dissections more correctly, think that there is a place entirely destitute of medullary substance, of an oval form and surrounded with smooth and distinct edges.

This thin place becomes very apparent only when the vitreous humor is compressed to push the fold outward and to efface it.

(1) Buzzi, in the *Opusc. sulle scienze e sulle arti*, Milan, vol. v., 1784, and vol. vii. —Sœmmerring, *De foramine centrali limbo tutco cincto retinæ humanæ;* in the *Comm. soc. Gott.*, vol. xiii., 1795–1798.—P. Michaelis, *Ueber einen gelben Fleck und ein Loch in der Nervenhaut des menschlichen Auges;* in the *Journal der Erfindungen*, part xv., p. 1–17, 1796, and cah. xvii., p. 133.—J. C. Reil, *Die Falte, der gelbe Fleck und die durchsichtige Stelle in der Retzhaut des Auges;* in the *Archiv. Für die Physiologie*, vol. ii., p. 468–797.—E. Home, *An account of the orifice in the retina of the human eye;* in the *Phil. trans.*, 1798, p. ii.—*Exposé des résultats de plusieurs recherches sur la tache jaune, le pli et le trou central de la rétine, d'après deux mémoires communiqués par Marc et Léveille;* in the *Mémoires de la soc. méd. d'Em.*, vol. i., 1802, p. 364–397.—J. M. Wantzel, *Ueber die Home'schen Entdeckungen, das Loch, die Falte und den gelben Fleck im Mittelpunkt der Retzhaut betreffende;* in Rosenmuller and Isenflamm, *Beytragen fur die Zergliederungskunst*, Leipsic, 1800, vol. i., part ii., p. 201.

(2) Reil, *loc. cit.*, p. 470.

II. HUMORS OF THE EYE.

A. VITREOUS HUMOR.

§ 2001. The posterior part of the eye is occupied by the *vitreous humor* or *body* (*humor vitreus*, s. *corpus vitreum*), which corresponds in its situation to the choroid membrane and the retina.(1)

This humor is perfectly transparent, thin, and formed almost entirely of water, which contains a small quantity of the hydrochlorates and the lactates, with still less of albumen and soda.(2) It is contained in a special, very thin, delicate, transparent membrane, which every where surrounds it, and which is termed the *hyaloid* membrane (*tunica hyaloidea*). This membrane sends internally numerous prolongations in the spaces of which the liquid is contained as in so many cellules. The union of the membrane and of the liquid which forms it, is properly speaking, the *vitreous body*.

This body presents on its anterior face a slight cavity which is connected with the crystaline capsule, the posterior part of which is situated there, and adheres to it so intimately in the normal state that it cannot be detached from it, at least when the eye is perfectly fresh, without tearing the hyaloid membrane.

2002. Between the great edge of the crystaline capsule and the anterior part of the hyaloid membrane, a little behind the anterior edge of this latter, is a thin layer, termed the *ciliary* layer (*lamina ciliaris*, *zonula Zinnii*), which is extended like a bridge on the most anterior part of the vitreous body, in connection with which it circumscribes a triangular space, the base of which is formed by the posterior part of the circumference of the crystaline capsule, while the two branches are constituted, one by the layer, and the other, by the most anterior part of the vitreous body.

This empty space surrounds the crystaline and the vitreous body. It is termed the *canal of Petit* (*canalis*, s. *circulus Petiti*). It is easily demonstrated by inflating it with air.

(1) F. Martegiani (*Nova obs. de oculo humano*, Naples, 1814, p. 19) admits between the vitreous body and the retina an empty space, in the centre of which is the central artery of the retina, termed by him the *area Martegiani*, in honor of his father. J. Cloquet seems to admit the existence of this deviation, for he says (*De la squelettopée*, Paris, 1819, p. 72,) that the hyaloid membrane is reflected on itself on a level with the entrance of the optic nerve into the eye, to form a canal which passes from behind forward directly through the vitreous body. He proposes to call this passage the hyaloid canal, and asserts that it always exists in man. F. T.

(2) According to Berzelius (*Animal fluids*; in the *Med. chir. trans.*, vol. iii., p. 253), one hundred parts of the vitreous humor contains 98,40 of water, 0,16 of albumen, 1,42 of the hydrochlorates and lactates, 0,02 of soda and an animal matter completely soluble in water.

The ciliary layer presents numerous fissures, the direction of which is from before backward and from within outward, because it corresponds exactly to the inner face of the ciliary body, which is intimately united with it, and the folds of which are situated in its depressions. Its external face seems blackish after the ciliary body is removed, because the pigment remains attached to it there. When the canal of Petit is inflated, it is raised, its grooves become more superficial, and its external face seems formed of rounded or triangular eminences which project but slightly and are near each other.

This layer is thicker than the hyaloid membrane; still as it is united with this latter, and as the posterior edge of the layer is continuous with it, we have reason to say that the hyaloid membrane is divided at its anterior part into two layers, of which the external gives rise to the ciliary layer, while the internal is adapted to the posterior face of the crystaline capsule.

Ribes(1) asserts that canals exist between the ciliary layer and the ciliary body, which canals conduct the aqueous humor in the chambers of the eye, and take it up again from these two cavities. He supports his opinion by the dilatation of these pretended canals in an eye affected with hydrophthalmia, and the escape of the vitreous humor, when the eye is suspended by the optic nerve, after removing the transparent cornea. But these facts do not demonstrate it sufficiently. The first phenomenon depends probably on the general accumulation of serum in the eye, as there is also a considerable collection of serum between the crystaline lens and the vitreous body. We have every reason to think that the second depended on the pressure of the vitreous body on a part which ought to yield more easily after cutting the transparent cornea.

III. CRYSTALINE LENS.

§ 2003. The *crystaline lens* (*lens cristallina*)(2) is a soft, rounded body, perfectly transparent in the normal state, the breadth and height of which are almost double its thickness, and the posterior face of which is much more convex than the anterior; at least an inverse relation between its two faces rarely exists, and they are more frequently similar. The posterior face is generally a segment of a sphere about from six to nine lines in diameter, while the anterior is a segment of a sphere about five lines in diameter.

(1) *Mém. de la soc. méd. d'émul.*, vol. viii., p. 622–624.

(2) A. F. Walter, *De lente cristallina oculi humani*, Leipsie, 1712.—Petit, *Mémoire sur le cristallin de l'œil de l'homme, des animaux à quatre pieds, des oiseaux et des poissons*; in the *Mém. de Paris*, 1730, p. 4–33.—S. G. Sattig, *De lentis crystallinæ structurâ fibrosâ*, Halle, 1794.—B. F. Baerens, *Diss. sistens lentis crystallinæ monographiam*, 1819.—Leiblein, *Bemerkungen über das System der Krystallinse bey Saughthieren und Vogeln*, Wurzburg, 1821.

The thickness and the convexity of the crystaline lens are not always in the same proportion, as there is no constant relation between these two qualities and the breadth and height of the lens.

The crystaline lenses of the two eyes in the same man sometimes differ very much in form.

This body is situated before the vitreous body, the concave anterior face of which receives its posterior face, below the ciliary body, the internal face of which is partly attached to its great edge. It is situated behind the iris, with which it is not connected.

It however is not loose. A thin but solid membrane which is transparent and much thicker than that of the vitreous body exactly envelops it in every part.(1) This membrane, termed the *crystaline capsule* (*capsula cristallina*), is the medium of connection between the crystaline lens and the adjacent parts.

The crystaline lens is loose in its capsule. It is at most attached only by extremely minute vessels, which are detached from this membrane and enter its substance.

Between it and the capsular membrane is a transparent and very thin fluid, termed the *humor of Morgagni* (*liquor Morgagnii*).(2)

§ 2004. The crystaline lens is formed of two substances, one external and soft, the other internal and harder. These two substances blend together imperceptibly. The first is termed the *cortical layer*, and the second the *nucleus*. The cortical substance can be easily separated from the nucleus by crushing it between the fingers.

A special process is necessary to demonstrate this texture; but when the most complex means are employed, the crystaline lens is proved to be much more complicated than it seems at first view, and it may constantly be reduced into a certain number of parts.(3)

In fact by maceration and by the action of acids this body is divided in its whole extent from before backward into several triangular segments, the summits of which are turned inward and the bases outward, and which unite in the centre of the lens. Besides each segment also divides into numerous small laminæ, which are situated one above another from without inward, and which cover each other like the coats of an onion.

These layers are reflected from before backward on the outer edge of the crystaline lens, in the centre of which they accordingly terminate by two points, an anterior and a posterior.

(1) Petit, *De la capsule du cristallin ;* in the *Mém. de Paris*, 1730, p. 622-643.

(2) Graefe, *Ueber die Bestimmung der Morgagnischen Feuchtigkeit der Linsenkapsel und des Faltenkranzes ;* in Reil, *Archiv. für die Physiologie*, vol. ix., p. 225-236, and in *Abhandlungen der Erlanger Soc.*, vol. i., p. 389-396.

(3) A. Leeuwenhoek, *De formatione humoris crystallini in variis animalibus, de substantia fibrosa quæ in oculo apparet*, &c.; in the *Arc. nat. detect.*, Delft, 1695, p. 70.—Morgagni, in the *Epist. anat.*, A. 30, 31, 32, 33.—Sattig, *De lentis crystallinæ structura fibrosa*, Halle, 1793.—Young, in the *Phil. trans.*, 1793.—Monro, *On the structure of the body of the crystaline lens, and whether the fibres which enter into its composition are muscular ; loc. cit.*, p. 85.

Their anterior half is often detached from the posterior, and the whole crystaline lens seems more or less evidently divided into an anterior and a posterior half by a fissure which extends from the circumference to the centre.

The layers which compose the crystaline lens are united by fibres which extend from one to another. They are likewise composed of fibres, the direction of which is parallel to their proper longitudinal diameter. These fibres consequently commence at the centre of the crystaline lens. Thus the tissue of the crystaline lens is lamellar and fibrous.(1)

Between these layers is a diaphanous humor, more abundant on the outside than on the inside, which seems like that existing between the lens and its capsule.

The segments of the crystaline lens in respect to their thickness and their lamellar texture, are more distinct on its outer than on its inner side. The fibrous texture is more evident in the inner part.

§ 2005. The crystaline lens almost entirely dissolves in water, excepting a small quantity of a transparent and insoluble membranous substance. Berzelius has found in it of one hundred parts: of water, 58.0; of a peculiar substance, 35.9; of hydrochlorates, lactates, and animal matter, all soluble in alcohol, 2.4; of animal matter, soluble only in water, with some phosphates, 1.3; of insoluble membranous residue, 2.4.(2)

It is particularly worthy of notice that, excepting the color, the peculiar substance which is coagulated by heat is perfectly similar in chemical composition to the coloring matter of the blood. It contains a little iron, while there is much carbon and iron in the pigment. The blood then seems to be decomposed, as the aqueous and vitreous humors contain only the water which contributed to form it. Hence why these two humors do not coagulate.

§ 2006. The *crystaline capsule* receives blood from the central artery of the retina and the vessels of the ciliary body.(3)

The central artery of the retina is distributed in great part by its anterior branches on the posterior face of the capsule, for its last ramifications on arriving at the anterior edge of the vitreous body are reflected from without inward, and converge towards the centre of this face; but there are also several small ones which pass on the external edge of the capsule and go on its anterior face.

The arteries which arise from the anterior edge of the ciliary body go exclusively on the anterior face of the crystaline capsule, and anas-

(1) Berzelius supposes, but wrongly, that it also includes a membrane divided into several compartments by internal septa, like those of the vitreous body (*Djurkemi*, vol. ii., p. 212). Finally, he observes, and justly, that this body cannot be referred to the class of fibrous organs, as has been done to a certain extent by Mayer (*Ueber Histologie*, p. 13), and by Heusinger unrestrictedly (*Histologie*, part i., p. 42), since it is entirely soluble in water. F. T.

(2) *Loc. cit.*, p. 254.

(3) J. G. Walter, *De venis oculi et arteria centrali retinæ*, Berlin, 1778.

tomose there with the ramifications of the central artery of the retina. In the fœtus they send off from behind forward numerous ramuscules, which are distributed on the posterior face of the pupillary membrane.

The vessels of the crystaline capsule and those of the pupillary membrane always correspond remarkably in regard to their arrangement and development.(1)

Finally the arteries of the capsule, especially those which arise from the central artery of the retina, send several very minute twigs to the lens which are distributed between its laminæ, so that the latter are not nourished, at least entirely, by absorbing the liquid which surrounds them.

Veins have not yet been strictly demonstrated in the crystaline capsule, although they are known to proceed on its posterior face. The latter empty into the veins of the choroid membrane, with which they open on the external face of the ciliary lamina.(2)

Farther, in the normal state there is no red blood in the crystaline lens or in the vitreous body.

We have not as yet discovered nerves in the crystaline lens nor in its capsule.

B. AQUEOUS HUMOR.

§ 2007. The *aqueous humor* of the eye (*humor aqueus*) is a perfectly clear and transparent fluid which fills the two chambers. It is composed almost entirely of water,(3) and is formed very rapidly.

ARTICLE THIRD.

MUSCLES OF THE EYE.

§ 2008. The eye is moved by six muscles.(4) Five of them arise from the floor of the orbit; the sixth comes from the lower part of its anterior circumference. They surround the sclerotica, to which they are attached and blend with it.(5)

(1) Hunter, in the *Med. commentaries*, London, 1762, p. 63, *note.*

(2) Walter, *loc. cit.*, p. 28, 29.

(3) Berzelius (*Djurkemi*, vol. ii., p. 208) has found, in one hundred parts, 98.10 of water; some marks of albumen; 1.15 of hydrochlorates and lactates; and 0.75 of animal substance, soluble only in water.

(4) C. Bell, *Recherches sur les mouvemens de l'œil et sur les usages des muscles et des nerfs renfermés dans l'orbite;* in the *Archiv. gén. de méd.*, vol. vi., p. 250 and 445.

(5) The aponeuroses which terminate them have been considered, but wrongly, as a special membrane between the conjunctiva and sclerotica. (E. Home and P. Smith, *Philos. trans.*, 1795, no. i., p. 11, and no. xii., p. 262.)

They are divided according to their direction into *straight* and *oblique*. The first are four in number. There are two oblique muscles.

I. STRAIGHT MUSCLES.

§ 2009. The *straight* muscles of the eye (*M. recti bulbi oculi*) are the *superior*, the *internal*, the *external*, and the *inferior*; but beside these names, founded on the changes they cause in the situation of the globe of the eye when they contract, they have received others also, drawn from the expression they give to the countenance, and from the state of the mind which their action designates.

Their common character, is that they all arise from the floor of the orbit by a short and thin tendon, and are attached to the anterior part of the circumference of the sclerotica by another thin but broad tendon.

I. RECTUS SUPERIOR.

§ 2010. The *rectus superior* muscle (*M. rectus oculi superior*, s. *attollens*, *s. superbus*), arises from the periosteum of the orbit, between the optic foramen and the upper sphenoidal fissure, between the upper part of the optic foramen and the sheath of the optic nerve, directly below the levator palpebræ superioris muscle. It goes forward, resting on the upper part of the globe of the eye, becomes broader and thicker from behind forward, and is attached by a broad but thin tendon, to the sclerotica alone, two lines above the transparent cornea.

It is the second in size among the straight muscles of the eye. It is a little shorter but much thinner than the following muscle.

It raises the eye.

II. COMMON TENDON OF THE OTHER THREE STRAIGHT MUSCLES OF THE EYE.

§ 2011. The other three straight muscles of the eye arise partly by a common tendon, or from a ligament which extends from the inner extremity of the sphenoidal fissure, to two or three lines before this point.

III. RECTUS EXTERNUS.

§ 2012. The *rectus externus* muscle (*M. oculi rectus externus*, s. *abducens*, s. *indignatorius*) arises by two heads. The lower, the larger, comes from the external face of the common tendon, where it adheres very intimately to the tendon of the rectus inferior muscle. The upper is much smaller, and is blended with the tendon of the rectus superior muscle, arises from the portion of the sphenoid bone comprised between the optic foramen and the commencement of the sphenoidal fissure. Hence, the muscle proceeds along the centre of the external

wall of the orbit, situated on the periosteum, and is attached by a thin tendon to the outer part of the edge of the sclerotica, some lines from the edge of the transparent cornea. It is broader at its centre than in the rest of its course, and is much flatter and thinner from without inward than from above downward.

It is the largest, and particularly the thickest of the straight muscles of the eye: it is a little shorter, but infinitely thicker than the obliquus superior muscle.

It carries the eye outward, and acts when looking to the outside.

IV. RECTUS INFERIOR.

§ 2013. The *rectus inferior* or the *depressor oculi* muscle (*M. rectus oculi inferior*, s. *deprimens*, s. *humilis*), unites with the lower head of the rectus externus and rectus internus muscles, arises from the common tendon, and never comes from the sheath of theoptic nerve. It goes from before backward, and from above downward under the optic nerve, and is attached to the sclerotica.

It is the third in size of the recti muscles of the eye, but it is thinner and shorter than the rectus internus muscle.

It depresses the eye.

V. RECTUS INTERNUS.

§ 2014. The *rectus internus* muscle (*M. rectus oculi internus*, s. *adducens*, s. *amatorius*, s. *bibitorius*) arises by two heads. The inferior or external comes from the upper and internal part of the common tendon. The superior or internal is the larger, and arises from the inner part of the sheath of the optic nerve. This latter blends with the origins of the rectus superior and the levator palpebræ superioris muscles. Thence the muscle goes inward and forward, along the inner wall of the orbit, from which it is separated by a layer of fat. Its short and thin tendon is attached to the inner part of the circumference of the sclerotica.

It is the shortest of the four recti muscles, but it is thicker than the superior and inferior.

It draws the eye inward.

II. OBLIQUE MUSCLES.

§ 2015. The *oblique muscles of the eye* (*M. obliqui bulbi oculi*) are distinguished into *superior* and *inferior*. They turn the globe of the eye on its longitudinal axis in opposite directions.

I. OBLIQUUS SUPERIOR.

§ 2016. The *obliquus superior* muscle, *grand oblique*, Ch. (*M. oculi obliquus superior*, s. *longus*, s. *trochlearis*, *patheticus*), arises from

the posterior part of the inner face of the internal wall of the orbit, before the optic foramen, and also arises from the sheath of the optic nerve by a thin and short tendon. Thence it goes upward and forward along the upper edge of the internal wall of the orbit, and becomes near its anterior extremity, a long rounded tendon.

This tendon immediately enters into a small cartilaginous layer about two lines long and broad, which is reflected on itself, and thus represents a semicanal, open upward, forward, and backward, and forms a pulley, the anterior edge of which becomes a pointed prominence, while the upper edges are attached by ligamentous fibres to the upper part of the internal wall of the orbit.

The tendon is kept in this pully by a loose and movable cellular tissue. Its direction changes, so that on emerging it descends from before backward, and from within outward. It then becomes broader, and is attached to the inner and upper part of the sclerotica, on the inside of the tendon of the rectus superior muscle which partially covers it.

This muscle is the longest and thinnest muscle of the eye.

It draws the eye forward, inward, and upward.

Sometimes, but rarely, it is more or less perfectly double.

II. OBLIQUUS INFERIOR.

2017. The *obliquus inferior* muscle, *petit oblique*, Ch. (*M. oculi obliquus inferior*), the shortest muscle of the eye, differs from the other muscles in its origin and direction. It arises by a short tendon from the inner extremity of the lower edge of the orbit, goes upward and outward, then becomes a short and broad tendon, which ascends below the anterior part of the rectus externus muscle, and between the muscle and the globe of the eye, and is attached to the sclerotica, some distance behind the tendons of the recti muscles, between that of the externus and that of the superior.

It rotates the eye on its axis, first outward, then downward, and finally inward. It also draws the eye a little forward.

ARTICLE FOURTH.

FUNCTIONS OF THE EYE.

§ 2018. The eye represents an optical instrument,(1) composed of several transparent substances situated successively from without in-

(1) G. G. Ploucquet, *Diss. sistens momenta quædam physiologica circa visum*, Tubingen, 1797.—J. Campbell, in Thomson, *Annals of philosophy*, vol. x. p. 17–29.—Dunglison, *ibid.*, no. 60. p. 432.—T. Young, *Of the mechanism of the eye*; in the *Phil. trans.*, 1801, p. 81.—E. Hall, in the *Journal of sciences and the arts*, no. x. p. 249–257.—A. Horn, *The seat of vision determined*, London, 1815.—M. T. Muhlibach, *Inquisitio de visûs sensu*, Vienna, 1816.—J. Purkinje, *Beytrage zur Kenntniss des Sehens in subjehtiver Hinsicht*, Prague, 1819. Troxler, in Hindly, *Ophthal Bibl.*,

ward, which differ in density, although in all, this is greater than that of the atmosphere. The rays of light which enter it gradually converge on passing through it, so as to form but one fasciculus, which paints the image of the object at the bottom of the eye on the retina. The impression upon this membrane extends to the brain along the optic nerve, and there produces the sensation of sight.

The transparency of the centres which form the eye, the sensibility of the retina, and the conducting power in the optic nerve, are then the principal conditions necessary to sight. The opacity of one or several of the centres which concur to form the eye, the paralysis of the retina and of the optic nerve, the alterations in the texture of all these parts, the abnormal productions which are developed within or around them, consequently alter or destroy the sense of vision. The globular form of the eye favors the refraction of rays of light. Hence, why the general form of the eye and of its different parts very much influence the distance at which objects are seen clearly. When the eye is very convex, the rays of light are forcibly refracted, and we cannot discern objects which are near (*myopia*). When the eye is flattened the refraction is less, and only distant objects are seen clearly (*presbytia, presbyopia*). Hence, why myopia belongs only to youth and infancy, and presbytia to old age. The eye possesses also the power of modifying its form, the relations of its constituent parts, its situation, and its direction, either to obtain a distinct view of objects situated at different distances, in a ray of a certain breadth, or to see without moving the head or body, those which occupy the different points of a portion of a surrounding sphere. This last effect is produced by the action of the six muscles of the eye. The other depends on the contraction of the muscles, partly on the modifications in the secretion and excretion of the humors of the eye, partly on the action of the ciliary body, since these three causes united change the curve of the transparent cornea and the crystaline lens, as also the situation of this latter in regard to the cornea and the base of the eye.(1) The dark color of the pigment tempers the violence of the impression which the light would otherwise cause on the retina, which is extremely sensible,(2) for this black

vol. i. p. 21-99.—Meyer, *Das Auge, ein Hohlspiegel;* in *Deutsches Archiv für die Physiologie*, vol. v. p. 54.—M. G. Plagge, *Neue physihalische Ansicht des Sehens: ibid.*, vol. v. p. 97.—Id. *Neuer Beytrag zär Lehre von Sehen:* ibid., vol. vii. p. 213.—E. E. Rœdenbeck, *Quædam ad theoriam visus pertinentia*, Berlin, 1822.

(1) Simonoff has concluded from calculations, that it is not necessary to suppose the crystaline lens displaced, and that the clearness of vision of objects situated from two hundred and fifty millimetres to any distance, however great, depends only on their apparent diameters, and on the transparency of the air between. (*Réfutation de la prétendue nécessité mathématique du déplacement du cristallin pour conserver constante la distance focale de l'œil:* in the *Journ. de physiol. expérim.*, vol. iv. p. 260.) F. T.

(2) The sensibility of the retina is extreme only in regard to light. Magendie has determined that but a slight sensation is produced when this membrane is touched by a needle, and that even on scraping it, the pain is but slight, and not to be compared with that caused by pricking the surface of the eye. (*De l'influence de la cinquième paire sur la nutrition et les fonctions de l'œil:* in the *Journ. de phys. expér.*, vol. iv. p. 176.) This physiologist has also determined that the section of the two nerves of the fifth pair causes the loss of sight. F. T.

layer absorbs a part of the rays of light. This is the real function of the pigment, since vision is weak and imperfect when it has not its usual color. The iris also serves to moderate the intensity of the light which enters the eye, since this membrane dilates, and thus contracts the pupil, when the light is very vivid, or when we look at an object near, while it contracts and thus enlarges the pupil, when the light is weak, or when we look at rather a distant object.

ARTICLE FIFTH.

DIFFERENCES IN THE EYE DEPENDING ON DEVELOPMENT.

§ 2019. The eye differs considerably at different periods of life,(1) in respect to the existence, proportional volume, and form of the whole eye or of its parts.

The eye appears very early. It is visible at the fourth week of pregnancy as a black spot.

But at this period the globe of the eye is still exposed, for the eyelids do not exist. They begin to appear during the tenth week, in the form of narrow bursæ, which gradually enlarge. After about the twelfth week their edges touch, and they remain closed as in sleep until birth.

The lachrymal puncta, and generally all the lachrymal apparatus, as also the Meibomian glands, are proportionally more developed during the early periods of life than subsequently.

The eye is proportionally larger in the early periods of life than afterward. The two external membranes, the sclerotica, especially its posterior part, and the transparent cornea, are proportionally thicker. This character belongs especially to the cornea, which is twice as thick as it is in the adult, from a considerable quantity of reddish serum existing between its layers, in the full grown fetus, so that its anterior face is nearly plane, and the posterior touches the iris. It is also less transparent than subsequently. In old age it becomes planer, harder, denser, and more solid: we also see developed, in old men, a nebulum, which extends from the edge to the centre (*gerontonoxon*, s. *arcus senilis*), which undoubtedly depends on the slowness with which the substance is renewed, whence the fluids have more tendency to coagulate; this resembles those ossifications which supervene in old age in other parts of the body.

The choroid membrane also is proportionally thicker, and the black pigment which covers it has a deeper tint.

The pigment begins to appear very early at the fifth month of pregnancy. But before birth it is less colored than in the adult: it adheres less to the choroid membrane and the iris: it does not exist on the outer face of the first of these two membranes, so that the intensity of its

(1) J. G. Brendel, *De fabrica oculi in fœtibus abortivis observata*, Gottingen, 1752.

color and even its quantity seems to depend on the action of the light. In subjects at an advanced age, its color changes like the hair, and it is lighter, but the cornea and crystaline lens loose their transparency in the same proportion. The deeper color of the pigment in youth, depends partly on the fact, that the globules are nearer each other, partly also on their being blacker at this period. They are also softer in young people, and hence they lose their form, and are detached from each other by drying. In the full grown fetus, the white cellular tissue existing between the vessels of the choroid membrane, contains no iron, while there is much in that colored black found in the same place in the adult.(1)

The iris is one of the parts of the eye which varies the most at different periods; the greatest change is the closing of the pupil by the pupillary membrane (*membrana pupillaris*), or the *membrane of Wachendorff*, in honor of its discoverer.(2)

The external edge of this membrane arises from the inner edge of the iris. It fills the whole pupil, so as to separate completely the posterior from the anterior chamber. It is a very tense, rather solid, but very delicate, thin, and transparent membrane, so that when its blood-vessels are injected, they cannot be perceived until the eye is hardened by immersion in alcohol. It is composed of two layers, the anterior of which is a continuation of the serous membrane which lines the anterior face of the iris; and the posterior is very vascular, and is continuous with the posterior face of the iris. We have never known it to be covered posteriorly with a fibrous mucus, as Haller and Wachendorff assert.

Some of its arteries arise:

1st. From those which form the inner circle of the iris: they radiate from this circle towards the centre of the pupillary membrane, where anastomosing with the adjacent vessels, and not with those opposite, they terminate and leave a small space in the centre of the membrane. They also anastomose with each other frequently in their course.

2d. Other branches arise directly from the long ciliary arteries, pass on the iris, and go directly to the pupillary membrane, where they anastomose with the preceding.

3d. Others still smaller arise from the vessels of the anterior face and from the greater edge of the crystaline lens, and are distributed principally on the posterior face of the pupillary membrane.

(1) Coli, in Mondini, *loc. cit.*, p. 17.

(2) E. J. Wachendorff, in *Comm. Nor.*, 1740. Hebd. 18. p. 137.—Haller, *De nova tunica pupillam fœtus claudenti;* in the *Act. Upsal.*, 1742, and *Op. min.*, vol. i. p. 329.—J. G. Rœderer, *De fœtu perfecto*, Strasburg, 1750, § xxvi.—B. S. Albinus, *De membrana pupillam infantis nuper nati præcludente:* in *Annot., acad.* l. i. cap. vii. —Vicq-d'Azyr, *Sur la membrane pupillaire du fœtus:* in *Hist. de la soc. roy. de méd.*, ann. 1777 and 1778, p. 257.—J. F. Blumenbach, *De oculis leucæthiopum et motu iridis*, Gottingen, 1786.—H. A. Wrisberg, *De membrana fœtus pupillari:* in *Nov. comm. Gott.*, vol. ii. and in *Syllog. comm.* i.—Edwards, *Sur la structure de l'œil:* in the *Bull. de la soc. philomatique*, 1814, p. 21.—J. Cloquet, *Mémoire sur la membrane pupillaire et sur la formation du petit cercle artériel de l'iris*, Paris, 1818.—Portal, *Sur la membrane pupillaire:* in *Mémoires du Museum*, vol. iv. p. 457.

Veins have not been demonstrated with certainty on the posterior face of the pupillary membrane.

The pupillary membrane passes through several periods of development. Its primitive form is not known, nor the manner in which it is produced, nor the period of its first appearance.

According to Wrisberg it is not perceived distinctly before the third month of pregnancy. It is gelatinous and destitute of vessels until the fifth month, but at this period it becomes firmer and vessels are developed in it. Perhaps, however, in the early periods of life it is greater in proportion to the rest of the iris, for the devolopment of the latter membrane begins at its external edge.

It is most evident at the seventh month of pregnancy. It begins to disappear at the eighth month from the centre to the edge, that is, from the portion which has no vessels. In the full-grown fetus the only vestiges of this membrane are some small loose flocculæ attached to the edge of the pupil.

It generally disappears much sooner in animals born with the faculty of seeing than in those born blind; it continues in these latter also as long as the eyelids remain closed.(1) The vessels are not destroyed with it. They contract from the centre toward the circumference; their arches diminish, and they are finally adapted to the inner edge of the iris, where they form the small arterial circle, which does not exist so long as the pupillary membrane continues.(2)

Although this membrane perfectly separates the two chambers, each cavity constantly incloses an aqueous humor, which does not exist in the posterior alone as Edwards(3) and Ribes(4) assert. We have demonstrated this perfectly,(5) and Cloquet after us.(6)

A very curious periodical difference of the iris is a want of continuity of its circle, which is observed during the early periods of pregnancy, and which is very sensible at its inner part until about the seventh week.

The retina is much thicker in the early periods of life than afterward. This thickness does not depend on the greater development of its inner layer; and so far from the medullary layer being proportionally thinner at this period, so far from possessing at that time less medullary matter, as has been asserted,(7) this substance on the contrary is more abundant, and hence the increase of thickness presented

(1) Meckel, *Ueber die Dauer der pupillar Membran*; in the *Deutsches Archiv. für die Physiologie*, vol. i., p. 430; vol. ii., p. 136.

(2) In demonstrating this fact J. Cloquet has verified a conjecture of Blumenbach: *Ejusque (membranæ pupillaris) vasorum elliplici arcus sensim sensimque retrahuntur, tuncque, ni graviter fallor, annulum iridis interiorem efficiunt, cujus certe ante cum terminum nullum in fœtuum oculis vestigium reperire potui.* (*Inst. physiol.*, 1787, p. 208.)

(3) *Loc. cit.*

(4) *Loc. cit.*

(5) *Loc. cit.*

(6) *Loc. cit.*

(7) Brandis, *Pathologie*, Hamburgh, 1808, p. 241.

by the membrane. In old men the retina becomes extremely thin, but also more firm and resisting.

We already perceive its fold in the sixth month of pregnancy, and even in the full-grown fetus it is greater than in the adult. The thin place is visible, but the yellow tint does not appear till some time after birth. It gradually becomes more intense, but turns paler as age advances. It would seem that the fold diminished regularly and finally disappeared entirely. The less marked development in this region in old men is about in a direct ratio with the loss of transparency which gradually takes place in the cornea. The aqueous humor is turbid in the fetus. It becomes perfectly transparent during the first few weeks after birth.

The crystaline lens also is much more convex in the fetus and in infancy than in the adult. At first it projects through the pupil, and thus pushes the iris before it, so that it is separated from the transparent cornea only by this membrane, being situated in its special groove. In this respect and in the absence of the eyelids, the eye of the fetus resembles that of fishes.

This arrangement, added to the great thickness of the transparent cornea, causes the chambers to be smaller and the aqueous humor less abundant than in the adult. All the humors, however, excepting the aqueous, are more abundant in youth than subsequently, whence it follows that the whole eye, and particularly the cornea, projects more, while as age advances, the eye slightly collapses and the transparent cornea particularly flattens.

As age advances the crystaline lens assumes more consistence, and also becomes yellowish on leaving the centre, so that this tint is found generally in persons in advanced life. The same is true of the humor of Morgagni. At the same time this humor and that which fills the two chambers are slightly turbid, which is sometimes the case also with the vitreous humor.

ARTICLE SIXTH.

EYE IN THE ABNORMAL STATE.

§ 2020. The situation of the eye exposing it to the action of all external causes of injury, and its extreme sensibility rendering it liable to be diseased from the influence of these causes, or to participate in the affections of other parts of the body, and finally its very complex structure, singularly multiply the number of the anomalies it may present; these anomalies are more easily perceived even during life than in

most other organs, on account of its situation and the transparency of its parts.(1)

I. DEVIATIONS OF FORMATION.

§ 2021. Here, as in other organs of the body, the primitive deviations of formation are the most remarkable in respect to the consequences deduced from them in regard to the general theory of organization.

A. PRIMITIVE DEVIATIONS OF FORMATION.

§ 2022. I. The primitive deviations of formation in respect to quantity consist essentially in too slight an action of the formative power. They are:

1st. Deviations in formation from defect in development. Here we may mention:

a. The *absence* of the eye or of some of its parts. Here, as in the other organs, the conditions are not always exactly the same. In one case observed by Malacarne,(2) the optic beds and nerves, the common and the superior motor nerves, the globe of the eye, its muscles, the caruncula lachrymalis, and the optic foramina, were all deficient. The globe of the eye was replaced by a hard mass. The lachrymal apparatus and the eyelids were perfectly developed.

In another case(3) the globe of the eye and the optic nerve as far as its bed and the optic foramen were deficient, but the accessory nerves and the lachrymal gland were present.

b. Smallness of the organ.

(1) Beside the treatises on the diseases of the eyes, among which we may mention particularly those of Maître Jean, Taylor, Janin, Rowley, Beer, Scarpa, Schmidt, and Himly, beside also the works already mentioned, because their authors have examined it both in the state of health and that of disease, we shall mention, on the pathological anatomy of this organ, the following: J. C. Sybel, *Diss. de quibusdam materiæ et formæ oculi aberrationibus a statu normali*, Halle, 1798.—J. Wardrop, *Essays on the morbid anatomy of the human eye*, London, 1818.—Farre, *A treatise on some practical points relating to the diseases of the eye, by the late Conningham Saunders, to which are added*, &c., London, 1816.—Demours, *Traité des maladies des yeux*, Paris, 1818.—Helling, *Praktisches Handbuch der Augenkrankheiten*, Berlin, 1721.—Baratta, *Osservazioni pratiche sulle principali malatti e degli occhi*, Milan, 1821.—L. M. Mejra, *Tratado teorico y practico sobre las infermidades de los ojos*, Orea, 1820.—B. Travers, *Synopsis of the diseases of the eye*, London, 1820.—J. Veteh, *A practical treatise on the diseases of the eye*, London, 1820.—Consult also, on the pathological anatomy of the lachrymal organ, J. A. Schmidt, *Ueber die Krankheiten des Thranenorgans*, Vienna, 1803.—C. H. Tode, *Des maladies de la glande lacrymale*; in the *Mélanges de chirurgie étrangère*, Geneva, 1824, p. 391.

(2) *I sistemi*, Padua, 1803.

(3) Weidele, in Himly, *Ophthalmolog. Bibliothek.*, vol. iii., p. 2, p. 170.

c. The abnormal continuance of parts primarily existing, particularly of the pupillary membrane.(1)

d. The adhesion of the two eyes. It is rather a general law in this case that the eye formed by the fusion of the two in one is situated directly on the median line, and is symmetrical in its structure.

2d. Deviations in formation or in regard to quantity in an opposite sense when the body and head are normal, are very rare, and perhaps have never been observed.

II. The deviations of formation in respect to quality are also rare. They affect most frequently the form of the iris and that of the pupil, which then is usually less round and most commonly perpendicular, rarely horizontal. This anomaly, often peculiar to certain families, and hereditary, is always curious as an analogy with animals.(2) The iris is rarely enlarged so much outward that the pupil does not correspond to the axis of the eye, being carried much more inward.(3)

The transparent cornea is sometimes conical (*staphyloma conoides*), and at the same time it is more or less thin. This state is its greatest degree of convexity, whence this includes also the greatest degree of myopia.

Sometimes the cornea presents an opposite arrangement, being not sufficiently convex or entirely plane.

B. ACCIDENTAL DEVIATIONS OF FORMATION.

§ 2023. The *accidental deviations of formation* are more common than the preceding and very various, but they depend most generally on a previous alteration in the chemical composition, and the texture of the parts is then more or less changed. The principal deviations of this kind are:

1st. *Absence.* Here we may mention the loss of the eyelashes and eyebrows, caused by the destruction of their bulbs, by inflammations and ulcerations of the eyelids.

2d. *Alterations in size.*

a. Smallness. In blindness, the whole eye or at least some of its parts, particularly the optic nerve and the retina, are often wasted.

We have found several times in subjects who have been blind for a long time, that the retina was unusually thin and destitute of medullary substance in several parts of its extent, this substance existing at intervals.

When the power of vision is more or less diminished, the yellow spot also returns to the degree of color it presented before the eye was exposed to the light, for in this case its tint is more or less enfeebled.

(1) See our *Handbuch der pathologischen Anatomie*, vol. i., p. 396.
(2) See our *Handbuch der pathologischen Anatomie*, vol. ii., p. 158.
(3) Demours, tab. lxiv., fig. 1.

At the same time the fold is more or less effaced.(1) Sometimes in subjects affected with amaurosis the retina presents in this place black spots;(2) but only the diseased eye undergoes this change; the fold and the spot are on the contrary sometimes more sensible in that of the healthy side;(3) the optic nerve is even sometimes larger than in the normal state.(4)

The optic nerve is generally thinner and gray like horn.

The transparent cornea sometimes becomes much flatter after diseases of long duration and excessive evacuations.

The crystaline lens, left in the eye after separating it from its capsule partially or wholly, disappears very rapidly. At the end of a few years there is hardly a piece as large as a pin-head.(5)

b. Enlargement. The eye sometimes enlarges so much from dropsy (*hydrophthalmus*), that it projects on the outside of the orbit. This dropsy is situated primitively in the vitreous body; but it extends to every part, so that in some subjects we find considerable serum between the crystaline lens and the vitreous body.(6) Scarpa states that dropsy of the posterior part of the eye is usually attended with an increased secretion out of the vitreous body, as we have found several times on the inside of the choroid membrane and of the retina a great quantity of limpid serum, in which is a cord directed from before backward, formed by the morbid alteration of the vitreous body and retina.(7) In this case probably the serum came from the serous membrane discovered by Jacob.

A partial enlargement of the eye, often met with, forms *staphyloma*,(8) a greater or less thickening of the transparent cornea, which causes the falling of this membrane, attended with its opacity, and depends on a previous inflammation situated in it. In this case the cornea generally adheres to the iris. The increase with the thinness of the sclerotica, which is much rarer and is also termed *staphyloma*, appears under the form of bluish elevations, the color of which depends on the varicose state of the vessels of the choroid membrane. It supervenes principally on the circumference of the transparent cornea after arthritic ophthalmia, but is observed more rarely at the posterior part of the sclerotica.(9)

The lachrymal sac is more or less distended after inflammation of the lachrymal passages.

3d. *Solutions of continuity.*

(1) Michaelis, *loc. cit.*, p. 8.—Reil, *loc. cit.*, p. 472.—Léveillé, in Wenzel, *De penit. struct. cereb.*, p. 167.
(2) Wenzel, in Michaelis, *loc. cit.*, p. 9.
(3) Michaelis, *loc. cit.*, p. 3.
(4) Wenzel, *De pen. struct. cerch.*, no. xi.
(5) Scarpa, *Malattie degli occhi*, Pavia, 1801, p. 183.
(6) Ribes, *loc. cit.*
(7) *Malattie degli occhi*, p. 230.
(8) J. L. Friedrich, *Diss. de staphylomate*, Berlin, 1821.
(9) *Loc. cit.*, tab. ii., fig. 10.—Demours, *loc. cit.*, tab. lxiv., fig. 3.

a. Abnormal union. This anomaly is rather common, and always results from inflammation.

When the conjunctiva has been violently inflamed and neglected, the eyelids join either to the anterior face of the eye (*symblepharon*), or with each other (*ancyloblepharon*). Sometimes these two kinds of adhesion take place simultaneously. The parts fused are sometimes nearer each other, and are often united by a greater or less number of accidental membranes which vary in length. Sometimes they adhere at birth.

After inflammations of the iris, the pupil adheres (*synizesis*), or the anterior face of the iris unites to the posterior face of the transparent cornea, or finally the posterior to the anterior face of the crystaline capsule (*synechia*), by an effusion of albumen which coagulates, and which is sometimes distinct from the other parts in the form of a membrane.

The obliteration of the ducts of the lachrymal gland is caused by external lesions on the outside of the eye. It depends on inflammation and ulceration, like the contractions of the excretory channels of the lachrymal humor.

The shrinking (*myosis*) and the immobility of the pupil, observed after inflammations of the eye, very probably result from an effusion of albumen into its substance.

b. Abnormal separation. The parts of the eye rarely present this anomaly except from external injuries. We however must arrange here the detachment of the crystaline lens observed after violent cephalagia and the fall of this lens into the anterior chamber across the pupil, which results from the percussion or commotion of the eye.(1)

Ulcers produce especially in the transparent cornea, sometimes also in the iris, solutions of continuity, which, when situated in the first of these two membranes, cause the effusion of the aqueous humor and the falling of the iris. The iris is frequently detached in a greater or less extent from the sclerotica by a powerful shock: two pupils might then be said to exist. We must refer also to this head the abnormal enlargement of the openings, for instance, the pupil (*mydriasis*).

Ruptures and other lesions of one or more excretory passages of the lachrymal gland form the *lachrymal tumor* (*dacryops*), the accumulation of tears between the conjunctiva and the globe of the eye, or a too great effusion of this fluid.

Suppuration of the lachrymal sac frequently destroys a portion of it and its communication with the exterior, and thus produces *fistula lachrymalis*.

4th. *Deviations in situation.* These anomalies extend to the whole eye, or affect some of its constituent parts only. The globe of the eye may be pushed out of the orbit by tumors in its cavity (*exophthalmia*), and may fall forward from the injury or the paralysis of its

(1) Fribauli, *Observation sur un cristallin qui a passé par le pupille dans la chambre antérieure de l'œil;* in the *Journ. de méd.*, vol. lix., p. 72.

muscles (*ophthalmoptosis*), which changes more or less the situation of the eyelids, and causes them to turn over outward.

The direction of the eyelids alone is frequently changed, which may take place in two different modes, according as they are turned outward (*ectropium*) or inward (*entropium*). The latter effect is produced particularly by the destruction of the internal layer of the skin of the lid and the cartilage, after inflammation of the eyelids, by a dropsical state of these parts, sometimes by the paralysis of the levator palpebræ muscle. This paralysis however is never sufficient to cause it alone, it producing only the fall of the upper eyelid (*blepharoptosis*). The first state is caused principally by wounds in the skin with loss of substance, sometimes also by the development of tumors and excrescences on its inner face.

When the lid is turned inward, the eyelashes naturally touch the globe of the eye. Hence it is called *trichiasis*, in which only some lashes participate, which occurs after inflammations of the eyelids, and arises from the inner part of the edge of the eyelids being destroyed by ulcerations.

The prolapsus of the iris occurs in wounds of the transparent cornea, and when this latter membrane presents several openings through which the iris protrudes, a kind of staphyloma occurs which is termed the *bunch of grapes*. At first the protruded portion of the iris is exposed, soft, thin, and very vascular; it gradually becomes solid, the circulation stops, and it is covered by a thin, grayish white membrane, which Beer regards as the regenerated conjunctiva;(1) but it is more correct to consider it a new production formed by the exudation of the lymph from the iris.

The protrusion of the membrane of the aqueous humor, admitted by most writers, is a prolapsus of the vitreous body, as Scarpa has perfectly demonstrated.(2)

II. ALTERATIONS IN COMPOSITION AND TEXTURE.

§ 2024. Almost all the alterations of composition and texture in the eye, as in other parts of the body, depend on inflammation, to which this organ is very much exposed. Several of them however are developed, and we cannot consider them as resulting exactly from previous inflammation.

Alterations in texture are very rarely congenital. We must, however, regard as such the anomalies in the color of the eye, which may be referred: 1st, to a want of color in the pigment (*leucœthiopia*); 2d, to the different colors of the iris in the two eyes, or even in its different

(1) *Augenkrankheiten*, vol. ii., p. 63.
(2) *Loc. cit.*, p. 170.

parts in the same eye; 3d, to a want of transparency. Farar also(1) has observed, in three children of the same family, that the cornea at the moment of birth was clouded by a nebulosity, which afterwards gradually disappeared from the outside towards the centre.

The new formations which must always, or at least in most cases, be considered as consequences of inflammation, are principally the following:

1st. In the *eyelids*.

a. Grando, a rounded tumor, which varies in hardness and is developed on or a little below the lower edge. It is a purulent cyst, a *stye* (*hordeolum*), not entirely destroyed by suppuration, and which is filled with coagulated albumen.

b. Sarcoma of the eyelid, which is red and at first soft, afterwards harder, and which is developed on the inner face of the eyelids, particularly in lymphatic subjects.

Here we may mention the *encanthis*, a tumor situated in the caruncula lachrymalis and the third eyelid.

2d. *In the conjunctiva.* The *film* is a greater or less elevation which is developed between the anterior face of the sclerotica and the conjunctiva which covers it. The *pterygium*(2) commonly arises in the inner angle of the eye, where it extends outward to the anterior face of the transparent cornea, and beyond the centre of this latter. We rarely find a second or even a third in the external angle of the eye or in another region. It is more or less vascular, and its base always looks toward the circumference and its summit towards the centre of the eye, undoubtedly because the connection of the conjunctiva with the subjacent membrane is less intimate in the first place than in the second, where in fact it blends with the transparent cornea.

The *pannus* differs from the pterygium as it is the substance of the conjunctiva, and sometimes also that of the transparent cornea, which thickens. The tumor termed *pinguecula* is generally developed in the external angle of the eye, or at least on the outside of the cornea. It is seldom larger than a bean, and it is formed by the conjunctiva and the subjacent cellular tissue.

3d. *In the transparent cornea*(3) the principal results of inflammation are *maculæ* and *nebulæ* (*obscuratio*, *albugo*, s. *leucoma*), which sometimes arise only from simple exsudations in the tissue of the cornea, sometimes also are cicatrices of ulcers of this membrane, and vary in their extent and their degree of opacity. In the first case, the surface of the cornea does not differ at the spot where the point is, from

(1) *Med. communic.*, vol. ii., p. 463.

(2) Beer (*loc. cit.*, vol. ii., p. 638) does not consider the pterygium as resulting from an inflammation. We may however mention in support of this not only his own opinion that the tumor usually appears when caustics are applied (p. 640), but also Larrey's observations, who remarked that it frequently was a consequent of the Egyptian ophthalmia.

(3) G. Mirault, *Mémoire sur la héraitc ou inflammation de la cornée transparente*; in the *Arch. gén. de méd.*, vol. iii., p. 5.

other parts; in the second it is deep. The cicatrix is always hard, like the spot produced by an old exsudation. Farther we observe no other alteration of texture in the place where it is situated.(1)

4th. *In the iris* the pupil is effaced (*atresia pupillæ*) by an opaque false membrane, which causes at the same time the adhesion of the posterior face of the iris to the crystaline (*synechia*) capsule. Then the production of pus or of a puriform fluid on the surface of the iris, whence a puriform congestion is formed in the chamber of the eye, which is termed *hypopon*. Searpa thinks that it is real pus which forms here, since we do not find in the iris an abscess the rupture of which could produce this purulent humor.(2) The serous nature of the two faces of the iris favors his opinion, but the authority of Beer(3) at least authorizes us to doubt it as a general rule.

5th. *In the crystaline lens and its capsule*, which are frequently the seat of *cataract* (*cataracta*, s. *suffusio*), which most generally renders opaque, parts normally transparent.

Cataract varies in situation, consistence, and color. It usually arises from opacity of the crystaline lens (*C. cristallina*, *C. lenticularis*), more rarely of the crystaline capsule, especially of its posterior face (*C. capsulaire*, *C. capsularis*), still more rarely in the humor of Morgagni (*C. laiteuse*, *C. Morgagniana*, s. *lactea*). These three kinds coexist in the *capsulo-crystaline cataract* (*C. capsulo-lenticularis*).

Opacity generally commences in the centre(4) and very deeply in the crystaline cataract, and on the contrary in the margin in the capsular cataract. Sometimes in the latter case only some parts are opaque, forming the *dotted* or *mottled* cataract (*C. fenestrata*). Most generally, but not always in old men, the crystaline lens is unusually hard, and in a measure ossified or petrified (*C. dura*). It is rarely softer than in the normal state (*C. mollis*), or even fluid (*C. fluida*). The capsule is more frequently hardened and thickened. Its anterior face is also covered in some cases (*C. trabiculata*, *pyramidata*) by a layer of substance, sometimes having the consistence of osseous tissue,(5) which arises from an exsudation formed by the inflamed iris, and which consequently can always be separated to a certain extent from the capsule.(6) The color of the cataract is most generally grayish white.

In the crystaline and the capsular cataract, the crystaline lens and its capsule are not unfrequently detached from each other, or from the adjacent parts, by a shock of the body. But they are sometimes connected more intimately, and so extensively that the crystaline capsule and the iris adhere.

(1) Wardrop, *loc. cit.*, p. 93.
(2) *Loc. cit.*, p. 149.
(3) *Loc. cit.*, vol. i., p. 436.
(4) Rudolphi (*Grundriss der Physiologie*, vol. ii., p. 184) mentions a family in Berlin in which the *central* cataract (*C. centralis*) is hereditary; this consists in a single dark point in the centre of the crystaline lens, which remains stationary.
(5) Beer, *loc. cit.*, p. 303.
(6) Beer, *loc. cit.*, p. 297.

In the pyramidal cataract the thick anterior wall of the capsule sometimes projects through the pupil and advances to the transparent cornea, to which it sometimes adheres.

6th. In the *vitreous* body, the loss of transparency (*glaucoma*) and the complete dissolution of it (*synchysis*), which usually attend gutta serena.(1)

§ 2025. The new formations developed in the eye are probably caused by an action similar to inflammation; we cannot, however, always consider them as resulting positively from this cause. They are divided as in every other part, into those which are abnormal only from the place where they are developed, and those which are entirely new.

1st. Among the tissues normally existing in other parts of the body we distinguish:

a. The cellular tissue, which, assuming the form of false membranes, unites parts which are primitively separate, and which we have already mentioned in this respect as produced by inflammation.

b. The vascular tissue, which arises in the same manner in the different new formations, especially in the preceding.

c. The serous tissue, which is developed in the eyelids, especially the superior, in the form of cysts within the lachrymal gland in the orbit,(2) more rarely between the choroid coat and the retina.(3) We probably can arrange here the cysts formed on the surface of the iris when this membrane projects through an opening in the transparent cornea:

d. The fibrous tissue, which occurs much more rarely. In one case the retina was changed into a white, fibrous, and very solid membrane, exactly similar to an aponeurosis, the external face of which adhered very intimately to an osseous layer between it and the choroid membrane.(4)

e. The osseous tissue, which generally appears in the form of more or less irregular thin layers between the choroid coat and the retina, probably from the change of the serous membrane which covers the outer part of the choroid coat. It is seen more rarely in the transparent cornea,(5) and it is probably developed primitively in the membrane of Descemet.

We must probably mention here the considerable and petrous hardening of the opaque crystaline lens and the formation of stony concretions in the place of the vitreous body; for the latter concretions, even when they become considerably thick, do not result from the change of the vitreous body, but from between the choroid membrane and the

(1) Heister, in the *Act. nat. cur.*, vol. i., p. 71.—Demours, *loc. cit.*, vol. i., p. 390.
(2) Beer, *loc. cit.*, vol. ii., p. 589, *note.*
(3) Portal, *Anat. méd.*, vol. iv., p. 418.
(4) Magendie, in Demours, *loc. cit.*, 73, vol. i.
(5) Walter, *Anat. mus.*, vol. i., p. 139.—Wardrop, *loc. cit.*, p. 72.—Anderson, *ibid.*, p. 73.

retina, and only push this body outward, since it is crowded and wasted in their centre.(1)

f. Among the constituent parts of the cutaneous tissue the hairs are probably the only ones abnormally developed in the eye, unless we refer to it those cysts which form around hernias of the iris, and which we have referred to the serous system. The conjunctiva seems to be the only part of the eye where the hairs take root. They sometimes appear also as abnormal eyelashes (*distichiasis*) on the inner edge of the upper eyelid after neglected ophthalmias, and differ from the common lashes in their situation, thinness, smallness, and whitish color.(2) They are rarely developed in the conjunctiva of the eye, where they appear either in the conjunctiva itself, which is most usual,(3) or on the transparent cornea.(4) In the cases observed by Himly they were inserted in the centre of a fatty production, and in all other cases, at least those detailed by Wardrop, and Demours, a pterygium or film was the base of them, that is, they were preceded by a morbid change. Himly and Wardrop have observed this formation in the external, and Demours in the internal angle of the eye. This latter case consequently resembles the considerable increase of one of the hairs of the caruncula lachrymalis, seen by Albinus.(5) It is curious that in the few cases of this anomaly as yet published, there is an evident connection between the period of puberty and the development of accidental hairs. In the cases described by Wardrop, the hairs did not appear till the age of sixteen years with the beard, and in that described by Himly the tumor appeared at the age of two years, but did not become troublesome till the age of twenty, doubtless because hairs were not developed upon its surface.

2d. The entirely new formations are:

a. Figlike excrescences which appear in the iris, from syphilitic inflammation.

b. Fungus hematodes, which is developed sometimes in the eye itself, and as it would seem on the posterior part of the choroid membrane, whence it goes forward, destroying before it all parts of the organ, and often extends to the outside of the eye in the fat of the orbit. Perhaps we ought also to arrange here the excrescences which are developed within the optic nerve.(6)

c. The entozoaries. To these may probably be referred, at least sometimes, the loose hydatids which appear in the lachrymal gland, and which are explained better in this manner than by attributing

(1) Scarpa, p. 269.
(2) Beer, *loc. cit.*, p. 119.
(3) Himly, *Ophthalm. Bibl.*, vol. ii., part i., p. 199.—Ware, *On entropion*, p. 7.—Wardrop, p. 31.—Demours, tab. lxiv., fig. 1.
(4) Gazelles, in the *Journ. de méd.*, vol. xxiv.
(5) *Annot. acad.*, book iii., cap. viii.
(6) Gallereux, in Demours, vol. i., p. 75.

them to a change of the cellular tissue.(1) The filaria Medinensis sometimes occurs below the conjunctiva.(2)

CHAPTER III.

ORGAN OF SMELL.

§ 2026. The senses of hearing and sight, the organs of which have been described, differ from the others in respect to their relations with other organs, as they are more independent. Those of smell and taste, on the contrary, are only portions of other organs, for they both belong to the digestive system, and the first also to the respiratory system. It would then be proper to consider the organs of smell, voice, and respiration, of taste, and of digestion, as forming a single system. It is impossible to separate the history of the tongue from that of the intestinal canal, since it is situated in a cavity, the commencement of the digestive apparatus, and in which the food is remarkably changed, since it is also situated behind the organs which cause these changes. But we shall consider the organ of smell separately, since it is more independent than that of taste, and after leaving the fishes it is entirely separated from the respiratory system, which in the three upper classes of animals communicates with the exterior, not only by the olfactory organ, but also by the oral cavity.

ARTICLE FIRST.

ORGAN OF SMELL IN THE PERFECT STATE.

§ 2027. The *organ of smell*, or the *nose*,(3) is composed:

1st. Of a bony cavity divided into several compartments, the upper and posterior part of which is more extensive, and is formed by bones, whence it is termed the *bony nose* (*nasus osseus*), and has already been described in osteology.

2d. Of an anterior, smaller, triangular, elongated, and cartilaginous portion, the *cartilaginous portion* (*nasus cartilagineus*).

3d. Of muscles which move this cartilaginous portion.

(1) Schmidt, *Krankheiten des Thränenorgans*, p. 75.
(2) Larrey, *Mémoires et compagnes*, vol. i., p. 223.
(3) Santorini, *Observationes anatomicæ*, Venice, 1724, cap. v., *De naso*, p. 84.—Ziervogel (Aurivillius), *De naribus internis*, Upsal, 1760.—A. Scarpa, *Anatomicæ disquisitiones de auditu et olfactu*, Milan, 1795.—T. C. Rosenthal, *De organo olfactus quorundem animalium*, Gripswald, 1807.—S. T. Sœmmerring, *Abbildungen des menschlichen Organs des Geruchs*, Frankfort, 1809.

4th. Of a mucous membrane which covers the osseous and the cartilaginous nose.

5th. Of nerves which are distributed in this membrane.

In considering the nose externally we distinguish an upper part or the *root*, an anterior edge or the *back*, and a lower part or the *tip*.

I. CARTILAGINOUS NOSE.

§ 2028. The *cartilaginous nose*, the anterior extremity of the bony nose, is composed of a central and perpendicular portion, the *cartilaginous septum* of the nose (*septum narium cartilagineum*), of two *alæ* (*pinnæ*, s. *alæ nasi*), finally of two oblong openings termed *nostrils* (*nares*), by which the cavity of the nose opens externally, and which are supplied, especially on their inside, with stiff hairs (*vibrissæ*.)

It is composed of several thin cartilages united with each other and with the bony portion of the nose, externally with the skin, internally with a mucous membrane. There are generally eleven.

The largest, the *cartilage of the septum*, is perpendicular and square. It completes the osseous septum anteriorly, where it is included between the perpendicular plate of the ethmoid bone, the vomer, and the median suture of the two proper nasal bones. Its anterior edge descends from before backward, is loose, and is attached to a long prolongation of the skin, the cutaneous septum of the nose.

The *superior lateral* cartilage is square and is attached to the lower edge of the proper nasal bone, to the ascending process of the superior maxillary bone, and to the upper edge of the preceding. It is generally blended with this latter so intimately that they form but one body.(1) Below this superior lateral cartilage, and at the side of the lower part of the median line, is the *inferior lateral* cartilage, or the *cartilage of the ala* (*C. pinnæ*), which is very low. This cartilage is narrow and formed of two pieces, an internal and an external, which unite forward at an acute angle, where they frequently present a foramen, and are sometimes entirely separated from each other. The external piece is longer and higher than the internal. Next come from before backward and from without inward several *square* cartilages; these are much smaller, diminish in extent from before backward, circumscribe the nostril backward and outward, and are often blended with each other and with the preceding. From two to five other still smaller *sesamoid* cartilages (*C. sesamoideæ*) are situated forward on each side, between that of the septum and the two lateral cartilages.

(1) Santorini, *loc. cit.*, p. 85.

II. MUSCLES OF THE NOSE.

§ 2029. The cartilaginous nose is moved by a great many muscles,(1) two of which belong to it exclusively and two are common with the adjacent parts.

A. LEVATOR ALÆ NASI LABIIQUE SUPERIORIS.

§ 2030. The *levator alæ nasi labiique superioris* or the *pyramidal* muscle, *grand sus-maxillo-labial*, Ch., arises from the nasal process of the upper maxillary bone, usually blends in this place with the frontalis muscle, descends in the side of the nose, and divides into two fasciculi, an anterior which is smaller, and is expanded in the lower lateral cartilage; the other is much larger, and blends with the orbicularis oris and the superior muscles of the upper lip. It raises the ala of the nose and the upper lip, and opens the nostril.

B. COMPRESSOR NARIUM.

§ 2031. The *compressor narium* muscle, *sus-maxillo-nasal*, Ch., is triangular, thick, and narrow at the base, and broad above. It ascends from the posterior part of the ala of the nose, where it is blended with the preceding, which partly covers it, and goes from behind forward toward the back of the nose, on which it unites with that of the opposite side without any intermediate tendon. It often gives off at the upper part, a prolongation which blends with the frontalis muscle. This is the *procerus* muscle of Santorini, the lower part of his *transversus nasi* muscle.

It contracts the nostrils when it acts from below upward, or from above downward, and never dilates them.

C. DEPRESSOR ALÆ NASI.

§ 2032. The *depressor alæ nasi* muscle, the *proper muscle of the ala* (*M. pinnarum*, s. *narium lateralis*, Santorini, s. *dilator narium proprius*, s. *inferior*), arises from the upper maxillary bone above the canine tooth and the external incisor. It is formed of oblique fibres, and extends almost the whole length of the outside of the cartilage of the ala of the nose. Its principal effect is to dilate the nostril when the nose is at rest. Being inserted in the upper maxillary bone, it can depress the nose. Finally, as its external face is attached to the integuments of the upper lip, it can also depress this latter.

(1) Santorini, *Obs. anat.*, cap. i., *de musculis faciei*, p. 11.—Id., *Tabulæ XVII.*, tab. i.—A. F. Walter, *Tener. musc. hum. corp. anat. repet.*, Leipsic, 1731.—Isenflamm has described and figured them in his *Praktische Anmerkungen über die Muskeln*, Erlangen, 1778, p. 345.

We sometimes find before it a proper, but much smaller muscle, to dilate the nostril; it is called the *myrtiform muscle of Santorini*, and sometimes surrounds the nose like a sphincter.

D. DEPRESSOR NARIUM.

§ 2033. The *depressor narium* muscle forms on each side a small fasciculus situated along the median line: it arises from the inner upper part of the orbicularis oris muscle, and is attached backward and inward to the inner branch of the cartilage of the ala of the nose. It draws the cartilaginous nose downward and backward, and also contracts the nostrils.

III. MUCOUS MEMBRANE.

§ 2034. The *mucous*, *olfactory*, *pituitary*, or *Schneiderian membrane of the nose*, has not the same nature in all parts. The proper nasal portion is more than a line thick in some places; it is thick, very red, and intimately fitted to the bones which it covers in every part; it contains numerous depressions and mucous follicles, and also at the lower and inner part of the nose, some small yellowish and distinct glands, which are imbedded in its peculiar tissue. At the anterior and inferior part of the nose it is thinner, harder, drier, and also provided with mucous follicles. If we except this latter portion, the pituitary membrane is covered in every part with very short villosities. At the lower edge of the septum there is not unfrequently a narrow canal, the direction of which is from behind forward, terminating posteriorly in a cul-de-sac, and which opens at some distance behind the anterior edge, evidently above the organ of Jacobson.(1)

The mucous membrane of the accessory cavities or of the sinuses, is externally thin, smooth, and yellowish white. It adheres but slightly to the surface of the bony cavities it covers, undoubtedly because numerous vessels and nerves do not enter it, through the substance of the bones.

IV. NERVES.

§ 2035. The nose receives its nerves from two sources, the olfactory and the second branch of the trifacial nerve.(2)

The olfactory nerve is undoubtedly the proper nerve of the organ of smell,(3) since when absent or compressed, the sense of smell is lost.

(1) Ruysch, *Thesaur. anat. III.* tab. v., fig. 5.—Jacobson, *Ann. du mus.*, vol. xviii. p. 412.

(2) J. Hunter, *A description of the nerves which supply the organ of smelling*; in *Obs. on different parts of the animal economy*, p. 239, tab. ix–xviii.—A. Scarpa, *loc. cit.*, cap. iii–vi.

(3) Magendie has doubted the proposition generally admitted in a memoir, entitled "*Le nerf olfactif est-il l'organe de l'odorat?* In the *Journ. de phys. expér.*, vol. iv. p. 169." Mery already doubted that the olfactory nerve was the organ of smell, and asserted that it was supplied by the fifth pair. (Brunet, *Progrès de la*

From the lower face of the prominence which terminates it, two series of filaments arise, an external and an internal, which correspond to the two series of foramina in the cribriform plate of the ethmoid bone, although two or three of them frequently emerge through the same foramen. They vary much in number and size. There are from four to twelve. The anterior go downward and forward, the middle directly downward, the posterior downward and backward. Shortly after leaving the olfactory nerve they enter the sheaths of the dura-mater, within which the posterior, particularly, pass a long distance before entering the foramina of the cribriform plate. They are covered first by the dura-mater, and flattened by the arachnoid membrane, which is less compact, and does not attend them as far. Entirely on the outside, each is surrounded by a tunnel-like prolongation of the dura-mater, which extends very far, and makes them apparently larger than they are on leaving the ganglion. They anastomose below the cribriform plate, descend between the bones and the pituitary membrane, soon ramify very much, and thus gradually approach the loose surface of the membrane.

Part of the internal series belongs to the septum, the component nerves of which pass entirely through it : the middle are the longest and the posterior the shortest.

They descend side by side, forming a single layer.

The external series is distributed in the sides of the nose, particularly in the two superior turbinated bones, forms considerable anastomoses, but the filaments formed by these nerves are much less compact than those of the external : they do not enter into the ethmoid cellules, and do not go to the mucous membrane of the inferior turbinated bones, or at least send forward but few and very minute ramuscules.

The olfactory nerve sends no filaments to the pituitary membrane of the sinuses.

mēdecinc, 1697.) Having opened the skulls of three or four men, in whom the organ of smell during life was unaltered, he found the pair of nerves callous near the cerebrum. Loder, however, (*Observatio tumoris scirrhosi in basi cranii reperti*, Jena, 1779,) has seen the olfactory nerve destroyed in a man destitute of the power of perception, and Oppert also has observed the same thing in a female, in whom the sense of smelling was deficient (*Diss. de vitiis nervorum organicis*, Berlin, 1815, p. 16). Cerutti (*Beschreibung der pathologischen Präparate des anatomischen Theaters zu Leipzig*, 1819, p. 208) mentions the cerebrum of a man who never possessed the faculty of smelling, in whom the olfactory nerve and its groove on the lower face of the inferior lobe were deficient. Rosenmuller even has described this case (*De defectu nervi olfac.*, Leipsic, 1817). But Rudolphi regrets, and with justice, that the turbinated bones of the septum were not examined, since in many cases, when it has been said to be deficient, it has been found, but very soft and diffluent. Farther, the facts related by Magendie, seem to give some weight to the old opinion of Mery ; at least they should draw the attention of physiologists to the sinuses of the nasal fossæ, to which Malacarne, Weinhold, Blumenbach, and Treviranus, have attributed very different uses, which are sometimes very trivial, as those mentioned by Weinhold. It would be important to prove, whether, as Deschamps and Richerand assert from experiments made on subjects affected with diseases of these cavities, they are unconnected with the olfactory function; but of this we may doubt until we have more information, especially since the fine researches of Treviranus on the fifth pair of nerves. F. T.

Among the nerves of the fifth pair or the accessory nerves of the nose, the superior nasal nerves go backward, the middle and the inferior nasal nerves, and the nerve of the septum which arise from the pterygo-palatine nerve, and the ethmoid nerve which comes from the nasal branch, go farthest forward, for they extend even before the olfactory nerve, and are distributed in the mucous membrane of the nose. These nerves also surround the surface in which the olfactory nerve is distributed, and anastomose with its posterior and external filaments. Those from the second branch of the fifth pair communicate also with the ethmoid nerve. Hence, the accessory nerves form a complete circle around the expansion of the olfactory nerve, like that formed by the ciliary nerves around the retina. Although they proceed much farther, they however occupy much less space than the twigs of the olfactory nerve.

§ 2036. The impressions of the odors are received by the olfactory nerve, and directly by the pituitary membrane. The portion of this latter in which the olfactory nerve is distributed, seems to be the principal seat of the faculty of perceiving them, although the membrane which lines the sinuses, partially contributes.

ARTICLE SECOND.

DIFFERENCES IN THE NOSE DEPENDENT ON DEVELOPMENT.

§ 2037. We have already mentioned in osteology, the principal periodical differences in the bony nose.

The whole organ long continues very imperfect. There is no trace of the external nose until the seventh or eighth week of pregnancy. At this time the nostrils appear, separated by a proportionally very broad septum, as two very small openings; little later the nose begins to project over the mouth; but during pregnancy it is blunt, and proportionally very small; a large nose in an infant is very unpleasant, because it is a character foreign to the early periods of life.

The cartilaginous structure of the external nose does not begin to appear till towards the end of the third month.

Until the end of the second, the nasal cavity communicates with that of the mouth. It is at first very narrow from above downward, and from right to left, on account of the greater breadth of the septum.

The nasal canals are formed at the end of the second month, by the still membranous prominences of the turbinated bones.

ARTICLE THIRD.

ORGAN OF SMELL IN THE ABNORMAL STATE.

A. NOSE.

§ 2038. The primitive deviations of formation in the nose(1) are:

1st. Its entire deficiency, which is very rare, is generally attended with the fusion of the two eyes in one.

2d. The union of the two halves of the nose in a tube situated below the single eye.

3d. Greater or less openings in the septum.

4th. Narrowness or closing of the nostrils.

5th. The abnormal communication of the cavity of the nose with that of the mouth, by the deficiency of a greater or less portion of the palate.(2)

6th. The more or less evident want of symmetry arising from an obliquity in the septum, which is sometimes so great that this latter even touches the wall towards which it inclines.

Most of these primitive deviations of formation are developed also consecutively during life, after the bony and musculo-membranous parts of the nose and palate are destroyed by syphilis.

The most frequent abnormal formations are the polypi of the pituitary membrane. Hydatids are infinitely more rare. They sometimes become so large that they considerably contract the nasal cavity.(3)

B. SINUSES OF THE NASAL FOSSÆ.

§ 2039. The *accessory cavities* or the *sinuses of the nasal fossæ*, present numerous and frequent anomalies.(4)

Their deviations of formation consist in their absence and narrowness, which are usually congenital. Sometimes these sinuses do not communicate with the nasal fossæ: but this anomaly almost always occurs, consecutively, after inflammation.(5)

Once, however, we found in the cadaver of an old woman the two maxillary sinuses completely closed, without any pathological change

(1) Deschamps, *Traité des maladies des fosses nasales et de leurs sinus*, Paris, 1804, p. 8.

(2) Portal, *Anat. méd.*, vol. iv. p. 499.

(3) Idem, *loc. cit.*

(4) L. H. Runge, *De morbis præcipuis sinuum ossis frontis et maxillæ superioris*, Rinteln, 1750.—Bordenave, *Sur les maladies du sinus maxillaire*; in the *Mem. de l'ac. de chir.*, vol. iv. p. 329.—C. A. Weinhold, *Ueber die krankhaften Metamorphosen der Highmorshöhle*, Leipsic, 1810.—F. D. Wagner, *Diss. de polypis narium et antri maxillaris*, Berlin, 1821.

(5) A. F. Rohowsky, *Diss. de choanarum obliteratione*, Berlin, 1815.—Otto, *Pathologische Anatomie*, p. 203, ann. 15.

in the texture of the pituitary membrane, and their surface also was moist as usual.

A greater or less quantity of liquid, however, often collects within them, from the effect of certain causes; this more or less forcibly distends them, their parietes become thinner, and are finally destroyed when the compression continues a long time, although this state does not deserve the name of *dropsy of the maxillary sinus*, because the effused liquid is not of the same nature as that exhaled by serous membranes.(1)

Entirely new formations, as fibro-cartilages and polypi, either alone or united, are not unfrequently developed in the accessory cavities of the nose. These formations are particularly common in the maxillary sinus, which is the most subject to morbid alterations, doubtless on account of the nearness of the teeth, and because the situation of its opening renders the escape of its secreted fluids more difficult. We may, however, blend them with the analogous tumors which are developed out of the antrum Highmorianum, in the zygomatic fossa.(2)

SECTION II.

OF THE VISCERA OR FORMATIVE ORGANS.

§ 2040. The *viscera*,(3) which may also be called the formative organs, because their essential function is to form new substances, present several general characters, the principal of which are as follow:

1st. They are situated principally in the trunk, and occupy only a small part of the lower region of the face, and are generally placed in cavities formed by bones, muscles, and serous membranes, which vary much in capacity. An aqueous vapor is effused between them and the parietes of these cavities.

2d. They are entirely, or at least in great part, and in their most important portions, enveloped by serous membranes. Each system is separated in this manner from the others, and each occupies a distinct section of the trunk.

3d. They receive most of their nerves from the ganglionnary system, and their nerves are always proportionally larger than those that go to the organs of sense, excepting always certain parts, as the tongue and the external organs of generation, which being abundantly supplied with nerves, possess a very acute and special sensibility, and are

(1) Runge, *loc. cit.*—Fauchard, *Chir. dentiste*, vol. i.—Sauve, *Cas d'hydropisie du sinus maxillaire;* in the *Bull. de la fac. de méd.*, 1818, p. 9.

(2) Lesage, *Sur une tumeur enkystée de la fosse zygomatique prise pour un polype du sinus maxillaire;* in the *Bull. de la fac. de méd.*, 1816, vol. v. p. 268.

(3) R. C. de Garengeot, *Splanchnologie, ou l'anatomie des viscères*, Paris, 1742.—Gavard, *Traité de splanchnologie*, Paris, 1809.—Boyer, *Traité de splanchnologie*, Paris, 1815.

in fact, real organs of sense. Most of the viscera receive their nerves from the ganglionnary system, and next from the pneumogastric nerve; but the hypoglossal, the glosso-pharyngeal, and the trifacial nerves, are also distributed in their upper portion, and the inferior spinal nerves in their lower portion.

The nerves usually pass some distance before arriving at the organs, and generally each of the latter receives nerves from one pair only. One pair of nerves is distributed in part to several organs.

4th. The course of the nerves in most of their extent is constant. As this condition does not exist in regard to those organs which receive their nerves from the ganglionnary system, we must conclude that it does not depend on the nature of this nerve. It is false that the spiritual principle is not connected with them, and the changes that take place in them are not perceived; this perception is very manifest in disease, and the sensations that result from them are not more vague or obscure than those ascribed to all the organs except that of sight.

5th. All the viscera are not united, at least in the perfect state, by mucous membranes. The respiratory and digestive systems communicate together in the neck, the urinary and genital systems in the lower part of the trunk; but the two latter are separated from the digestive system, or at least are connected with it only by the skin.

6th. These organs are much less symmetrical as to form and situation, than those of the senses.

7th. Their most important part is more or less evidently glandular. All are formed by several glands, the combined action of which is to correct the fluids secreted by them. The necessity of the combined action of several glands is very evident in the most complex system, that of digestion. Next come in this respect the genital organs, especially those of the male. The concurrence of several glands to form a new substance, seems least necessary in the urinary and respiratory systems.

A second part is composed of a canal formed of several different superimposed membranes, united by cellular tissue, and with which the gland or glands in general communicate, and which is sometimes open at its two extremities like the alimentary canal, or at one only, like all the others. The nature of the parietes of this canal varies extremely; they are, however, always formed of at least two superimposed layers, the external of which is condensed cellular tissue, and the internal a mucous membrane. The mucous membrane is covered sometimes in every part, as in the alimentary canal, sometimes here and there by a muscular tunic.

8th. These organs, if we except the genital organs, are, next to the centres of the nervous and circulatory systems, the most necessary for the support of life, although some of their parts may be primitively deficient, or be destroyed in some manner without occasioning severe accidents, and although very considerable alterations do not occasion immediate death.

CHAPTER I.

OF THE DIGESTIVE ORGANS.

§ 2041. The digestive organs comprise an uninterrupted canal open at its two extremities, and several appendages, which communicate directly or indirectly with different parts of this canal, within which they empty a fluid prepared by them.

This passage is termed the *alimentary canal* or *tube* (*canalis*, s. *ductus cibarius*). Its upper extremity is the mouth (*os*), and the lower the *anus*; both are situated opposite each other, and nearly on the same line. The canal is imperfectly divided by valvular prominences into several separate portions, which are named according to their form or functions. It is very convenient to admit three parts, which differ in functions, structure, and situation, but which are all repetitions of the same type; these are the *upper*, the *middle*, and the *lower* portion. The first occupies the head, the neck, and the chest; the other two, which form most of the digestive system, fill almost entirely the cavity of the abdomen. The upper portion is composed of the *oral cavity* (*cavum oris*), the *pharynx*, which is smaller than the mouth, and the *esophagus* (*gula*, *œsophagus*), which is still narrower, and with which the pharynx is continuous. Directly after passing through the diaphragm the alimentary canal enlarges to form a second pouch, called the *stomach* (*ventriculus*, *stomachus*), which is the commencement of the middle portion. Next comes a second narrower portion, the *small intestine* (*intestinum tenue*), which is divided, from slight and inessential differences, into the *duodenum*, the *jejunum*, and the *ileon*. The latter is continuous with the terminating portion of the intestinal canal, the *large* intestine or the *colon* (*intestinum colon*, s. *crassum*), which is divided according to the situation and direction of its different parts into an *ascending*, a *transverse*, and a *descending colon*. The latter is continuous also with the *rectum*, which opens at the *anus*. The small and the large intestines are termed the *intestinal canal* (*ductus*, s. *canalis intestinalis*).

The appendages of the intestinal canal are glandular organs resembling conglomerate glands; they are, the *salivary* glands and the *liver*.

The *salivary* glands (*G. salivares*) are situated around the cavtiy of the mouth, into which their secretion goes, and in the abdominal cavity near the upper extremity of the small intestine. They are consequently divided into the *oral* and the *abdominal salivary* glands (*G. salivares orales et abdominales*).

The *liver* (*jecur*, *hepar*) also occupies the cavity of the abdomen. The fluid it secretes is termed *bile*, and is poured into the duodenum near the last salivary gland.

We also find in the abdomen a glandular organ, which has no excretory canal, called the *spleen* (*splen*, *lien*).

All the portions of the digestive system in the abdomen, except the lower part of the rectum, are surrounded by a common serous membrane, the *peritoneum*.

§ 2042. The alimentary canal(1) presents several general characters which are simply modified in its component parts.

The tube it represents is formed of several layers which belong to different systems, so that each concurs specially to the general function.

The most internal and the most essential of these layers is the *mucous* or *villous* membrane (*tunica mucosa*, s. *intima*, s. *cribrosa*, s. *villosa*). It is soft and more or less vascular, incloses numerous small culs-de-sac or small muciparous glands, and its surface is moistened by the mucus which it constantly secretes, and a thinner fluid which is exhaled from it. It is in direct contact with the ingesta. The liquid which it secretes has a chemical and also a dynamical relation with the ingesta, since its action changes their composition, and they are divided into two parts, one of which, the *chyle* (*chylus*), serves for nutrition, while the other, the *fecal matter* (*fæces*), being useless, is expelled from the body. The chyle in its turn is so modified that it enters into the absorbing vessels which exist in this tissue.

The differences in this membrane relate principally:

1st. To its thickness.

2d. To its vascularity.

3d. To its color, which depends on the number of its vessels.

4th. To its solidity.

5th. To its extent, compared with the other membranes.

6th. To the presence or absence of prolongations and folds which project within it and vary in size, the former of which are called *valves*, the others *villosities*.

7th. To the nature of its surface, which is smooth or corrugated, and which depends on the preceding circumstance.

8th. To the number of the muciparous glands.

9th. To their size.

10th. To their situation and arrangement.

We may mention as a general law that the development of the inequalities on the inner face is inversely as that of the muciparous follicles, or still more generally that the prominences are inversely as the depressions; that the first are more distinct, the more nutrition there is in the contents of the intestinal canal, and that the cavities are more marked, the greater the quantity of fecal matter in the canal.

Considered from the commencement of the stomach to the extremity of the intestinal canal, the general character of this membrane is that it is perforated by very numerous small openings, which are the ori-

(1) F. Glisson, *De ventriculo et intestinis*, London, 1676.

fiees of single minute glands, and which are arranged very compactly.(1)

On its surface is a second membrane termed the *nervous*, or rather the *cellular* coat (*tunica nervea, cellulosa*).

This membrane is only condensed cellular tissue, in which the largest trunks of the vessels and nerves are distributed before arriving at the mucous membrane.

It contributes much to determine the form of the intestinal canal and of its folds.

The most external membrane is the *muscular* tunic (*tunica musculosa.*)

This membrane is composed in every part by several, at least two, superimposed layers, situated one above the other, and separated only by a very thin layer of mucous tissue.

The external layer is generally composed of longitudinal fibres, which are parallel to the axis of the intestinal canal and of the body. It is thinner than the internal, and it is extended on the intestine less uniformly.

The internal, on the contrary, is composed of circular fibres, is stronger than the external, and completely surrounds the intestinal tube.

The differences presented by this muscular tunic in the different regions of the alimentary canal relate:

1st. To the relation between it and the mind, according as its motions are voluntary or involuntary; in most of its extent these are involuntary; they, however, are voluntary at its upper and lower part.

2d. To its thickness and strength.

3d. To its more or less complex texture.

4th. To its color.

5th. To its attachments, according as it is inserted in the bones or connected with the adjacent parts by mucous tissue.

Besides these three layers there are also two others which are not so generally distributed: one resembles the epidermis, and covers the inner membrane; the other is given off by the peritoneum, and envelops the external tunic.

The most general character of the glandular appendages of the alimentary canal is, that these parts, except the spleen, are prolongations of the mucous membrane and of the cellular tunic, each of which ramifies like a tree. They differ then from the mucíparous glands on the external face of the villous tunic, because they are rather more distinct and are more concentrated in some parts of the alimentary canal.

(1) Galeati, *De tunicâ intestinorum cribrosâ;* in the *Comm. Bonon.*, vol. i.—Duverney, *Œuvres anatomiques*, vol. i., p. 480.—A. Meckel, *Sur la structure de la membrane muqueuse des intestins dans l'homme et dans quelques animaux;* in the *Journ. compl. des sc. méd.*, vol. vii., p. 209.

ARTICLE FIRST.

UPPER PORTION OF THE ALIMENTARY CANAL.

§ 2043. The upper portion of the alimentary canal may be subdivided into two regions, a *cephalic* and a *cervical* region.

I. CEPHALIC PORTION OF THE ALIMENTARY CANAL.

§ 2044. The cephalic portion of the alimentary canal comprehends the cavity of the mouth and the parts within it.

A. ORAL CAVITY GENERALLY.

1. PERFECT STATE.

§ 2045. The *oral* cavity (*cavum oris*) occupies the lower part of the face. It extends backward to the *fauces* and forward to the *lips*, by which it is continuous with the face. It is separated from the nasal fossæ above by the *bony* palate (*palatum osseum*, s. *durum*), and backward by the *soft* palate (*palatum molle*, s. *velum palati*). At its base is the tongue, and on its sides the lower jaw, the zygomatic arch, and the muscles, some of which are attached to these bones, others to other pieces of bone, and several of which also go to the mouth.

As the oral cavity is circumscribed by muscles and by bones which are movably articulated with each other, its form varies, although in general it is rounded and oblong. The alveolar portion of the upper and lower maxillary bones, together with the teeth which are inserted there, divide it into two halves, an anterior, which is smaller, and which may be called the *vestibule of the oral cavity*, and the posterior, which is larger. The first is included between the alveolar processes and the lips; the second is situated behind the alveolar arches. These two halves are perfectly separated from each other when the jaws are closed by the two rows of teeth which touch and fit each other from before backward. When perfectly at rest the posterior half contains the tongue and receives the excretory ducts of the inferior salivary glands, while those of the superior open into the anterior half. The oral cavity is covered on the outside by the common integuments, below which are the bones and muscles, then the *buccal* membrane (*membrana oris*), which envelopes every part of it.

The buccal membrane in fact begins at the upper part of the external faces of the lips, where the skin suddenly becomes softer, thinner, and redder.

It lines all the parts which circumscribe the cavity of the mouth, so that it perfectly closes the openings in the bony portion of the palate, the anterior and posterior palatine foramina. Around the alveoli it is uninterruptedly continuous with the membrane which covers them.

It forms folds in several places. Four of these folds are situated on the median line. The two most anterior exist between the centre of the anterior faces of the two maxillary bones and the upper and lower lips. They are both termed the *frena* of the lips (*frenulum labii superioris et inferioris*). The upper is much more distinct than the lower, which generally is hardly visible. The third is situated between the posterior face of the lower jaw and the anterior part of the inferior face of the tongue; it is called the *frenum of the tongue* (*frenulum linguæ*).

When too long or too short it is equally unfavorable to deglutition and speaking.

The fourth extends from the posterior extremity of the upper face of the tongue to the middle of the anterior face of the epiglottis.

The buccal membrane also forms:

1st. Two lateral folds, which extend from the upper face of the tongue to the edges of the epiglottis, where they terminate.

2d. Two lateral folds, situated on the anterior part, which extend from the alveolar edge of the two jaws to the inner face of the ramus of the lower jaw.

3d. Two other lateral folds, which cover the two arches of the soft palate.

Of these folds the most remarkable are those on the median line, as they make a part of the septum which extends all along the body.

The texture of the buccal membrane is not the same in every part. It however always presents two general characters:

1st. It is covered in every part by a soft, thick, and moist epidermis.

2d. It presents almost in every part single and large muciparous glands.

II. DIFFERENCES DEPENDENT ON DEVELOPMENT.

§ 2046. The form of the oral cavity changes remarkably. In the early periods of life it is proportionally shorter from before backward, especially at its lower part, than when the subject is fully grown. At this time the lips do not exist, so that the oral cavity is uninterruptedly continuous with the face, and its roof, the palate, not being closed, it is blended with the nasal fossæ, toward the upper part of which is the tongue, then proportionally very large. This horizontal septum is gradually developed from before backward by the union on the median line of the palatine portions of the superior maxillary and the palatine bones, and also the soft palate on each side. This union is rarely

perfect before the third month of fetal existence. The soft palate is perfect on the median line even before its two lateral parts are thoroughly united posteriorly, and the uvula descends from their centre between them as an entirely distinct and separate appendage. This soft palate is at first very broad, presents no appearance of an appendage, and is divided in its whole extent into two lateral halves. This division soon disappears, and at the same time the two lateral halves of the soft palate approach each other still nearer, and thus push the uvula a little forward, so that it covers the small fissure still existing in the anterior region of the palate. At this time its upper part is united to the two lateral halves, and the inferior passes downward a little below it. Finally the two halves of the soft palate completely unite with each other and with the uvula, and the formation is completed by the gradual prolongation of the latter. The perfect union of the uvula with the soft palate occurs at the middle or end of the fourth month of pregnancy. The uvula, however, until the end of the fifth month continues to be bifurcated, compared with its state in the adult, although it is united on each side with the soft palate, so that perhaps this period of its development is frequently extended beyond the usual time, although terminated before the end of gestation.

III. ABNORMAL STATE.

§ 2047. The most remarkable abnormal state of the cavity of the mouth is when its primitive formation continues, that is, when it communicates with the face and nasal fossæ, and the primitive fissures are not obliterated. This state of the upper lip is termed *hare-lip*, and that of the arch of the palate is termed *fissure of the palate*.(1) Generally then the solution of continuity in the lip or palate, excepting in the uvula, does not correspond to the median line, but occurs on one of the two sides, since it is situated also like the fissures by which the lips communicated primitively with the face. Farther, in the simple fissure of the palate we generally remark that the anterior and intermaxillary portion of the upper maxillary bone on one side is separated from the posterior; at least the solution of continuity is rarely situated on the median line, and the intermaxillary bones are seldom attached each to the corresponding maxillary bone, and the two maxillary bones with the palatine bones are not often separated symmetrically from each other and from the septum of the nasal fossæ.(2) The mode in which the uvula is developed explains why fissures in it are situated on the median line.

(1) Sandifort, *De labio leporino congenito, duplici et complicato;* in the *Obs. anat. pathol.*, book iv., ch. iii.—Tenon, *Sur quelques vices de la voûte palatale;* in his *Mém. et obs. sur l'anatomie*, Paris, 1816, p. 295.
(2) Tenon, *loc. cit.*, obs. i.

It is curious that however great this deviation of formation, it sometimes disappears at a more advanced period, and assumes the normal conditions of the regular type; the bony palate increases either alone or after the hare-lip is united, and the space between the oral and nasal cavities gradually fills up. This fact supports our previous conjecture that the two halves of the uvula sometimes unite in the fetus after the usual period of union.

The oral cavity presents those alterations of texture observed in all the mucous membranes. One of the rarest anomalies of this class is the development of hairs, which have been observed once on the surface of an encysted tumor in the fauces of a newly born infant.(1) It has been asserted that they have been seen also on the tongue.(2)

B. PARTS WHICH COMPOSE THE ORAL CAVITY.

§ 2048. The different regions of the oral cavity are:
1st. The *lips.*
2d. The *cheeks.*
3d. The *palate.*
We proceed to describe also:
4th. The *tongue.*
5th. The *teeth.*
6th. The *oral salivary glands.*

I. LIPS AND CHEEKS.

A. FORM.

§ 2049. The *lips* (*labia*) are prolongations which cover the anterior face of the alveolar edge of the jaws, being parallel with it. Their loose edges which look towards each other are more or less enlarged and turned over, that of the lower always more than the upper. The opening between them is termed the *mouth* (*os*).

The upper lip is longer and more prominent than the lower. We remark in it on the median line a longitudinal depression called the *philtrum*, which extends from the septum of the nose to the place where the skin becomes much thinner. This depression is remarkable on account of the space which primitively existed at the same place between its two lateral halves.

In the lower lip there is nothing similar, a difference which should be considered:

1st. Because we know of no instance of a fissure of the lower lip.

(1) Ford, in the *Méd. communic.*, vol. i., no. 51.
(2) Amatus Lusitanus, *Cæs. med. cent.*, ch. vi., p. 63.

2d. Because the depression of the upper lip seems to depend on the greater extent of the superior frenum, and on the separation of the superior maxillary bones, which always continues during life.

The places where the two lips unite are termed the *angles of the mouth* (*anguli oris.*)

The lips are insensibly continuous on each side with the *cheeks*.

Both regions are formed by a cutaneous, a muscular, and a mucous layer.

B. MUSCLES OF THE LIPS.

§ 2050. The different changes in the form of the cavity of the mouth, are produced by the action of the following muscles which occupy the regions of the lips, the cheeks, and the chin.

a. Orbicularis oris.

§ 2051. The *orbicularis oris* muscle, *buccal*, Ch. (*M. annularis, orbicularis oris, sphincter oris*), principally forms the fleshy layer of the lips, surrounds the mouth, and is situated between the skin and the mucous membrane. It is oval, thin, flat and broad, and is formed of concentric fibres. The external blend insensibly with those of its antagonists, or are prolongations of fibres of these different muscles which interlace together. These external fibres, however, are distinct, and are not blended. The internal form a separate order. They are found near the loose inner edge of the muscle and of the lips; but they insensibly disappear in the external fibres.

This muscle is united more intimately with the skin than with the mucous membrane. It contracts and closes the mouth, and draws up its angles.

b. Buccinator.

§ 2852. The *buccinator* muscle, *bucco-labial*, Ch., is situated between the upper and lower maxillary bones and the orbicularis oris muscle. It is square, broad, thin, and flat. Its fibres have generally a transverse direction; the upper, however, go obliquely from above downward and from behind forward, the inferior proceed in the opposite direction, and the central alone are straight. Its fixed points are the superior and the inferior maxillary bones. It arises from the external face of the alveolar edge of these two bones; its attachments commence behind the last molar tooth, and extend to about the second anterior. It also arises at its posterior part from the summit of the internal wing of the pterygoid process, and from a ligament which extends from that point to the alveolar edge of the lower maxillary bone. It is blended forward with the orbicularis oris muscle. The canal of Steno passes through it, near its anterior extremity.

It draws the lips and the whole mouth directly backward, contracts the cavity of the mouth, and consequently expels the substances in this cavity, so that it acts in blowing, whistling, expelling liquids from the mouth, sucking, forming the mass of food on the tongue, and in swallowing.

§ 2053. We may distinguish into *upper* and *lower* the following muscles which contribute to open the mouth.

The *upper* are, considering them from without inward:

c. d. Zygomatici.

§ 2054. The *zygomatici* muscles, *zygomato-labiaux*, Ch., are two in number, a *large* and a *small* (*M. zygomaticus major et minor*). Both are elongated and thin. The large is more round than the small, and is also situated further outward and backward. Both arise from the external face of the malar bone; sometimes, however, the small comes only from the external and inferior part of the orbicularis palpebrarum muscle, which generally sends some fibres to them. Both go obliquely from above downward, from without inward, and from behind forward. They blend with the orbicularis oris muscle; the small with that portion of this muscle which makes part of the upper lip; the large with that which extends to the angle of the mouth and to the lower lip.

Sometimes the zygomaticus minor muscle is deficient; in other cases its lower extremity is bifurcated; in some subjects it does not descend to the orbicularis oris muscle, but terminates in the outer face of the levator labii superioris and the levator anguli oris muscles.

These muscles draw the skin of the cheeks, the commissure of the lips, and the whole mouth, downward and outward. They consequently contribute to enlarge the mouth, particularly when they act on both sides at once.

e. Levator anguli oris.

§ 2055. The *levator anguli oris* muscle, *petit sus-maxillo-labial*, Ch. (*M. levator anguli oris*, s. *caninus*), is broader than the preceding, and is flat and elongated. It arises in the canine fossa below the infra-orbitar foramen, descends almost perpendicularly, becoming thicker and narrower, and blends in the angle of the mouth behind the zygomaticus major muscle with the orbicularis oris, and still more with the depressor labii inferioris muscle.

It raises the angle of the mouth and the upper lip.

f. Levator labii superioris.

§ 2056 The *levator labii superioris* muscle, *moyen sus-maxillo-labial*, Ch., is much larger than the preceding, and partly conceals its upper extremity, being covered in this place by the orbicularis palpe-

brarum; it has nearly the same form but a different direction, for it descends obliquely from without inward. It arises from the upper maxillary bone above the infra-orbitar foramen and is attached to about the middle of the upper lip, so that its fibres blend with those of the orbicularis oris, before which it descends.

It draws the upper lip obliquely upward.

g. Anomalus faciei.

§ 2057. Below the preceding and the levator alæ nasi labiique superioris muscle we not unfrequently find a long muscle which arises near the canine fossa of the upper maxillary bone, and is attached directly above the origin of the preceding; it is termed the *anomalus faciei* by Albinus (1) the *rhomboideus* by Santorini.(2)

It assists to raise the upper lip, and wrinkles the skin which covers it.

h. Levator alæ nasi labiique superioris.

This muscle has already been described.

§ 2058. The lower muscles of the mouth, considered in the same order as the preceding, are, the *depressor anguli oris*, the *depressor labii inferioris*, and the *levator menti* muscles.

i. Depressor anguli oris.

§ 2059. The *depressor anguli oris* muscle, *maxillo-labial*, Ch., called from its form the *triangular muscle of the lips*, arises from the anterior part of the lower edge and the anterior face of the lower maxillary bone. It ascends, contracting and becoming thicker towards the angle of the mouth, where it blends with the orbicularis oris, the zygomaticus major, and particularly the levator labii superioris muscle, so as to form with this latter a single muscle very much contracted in its centre, the fibres of which, however, are not interrupted by a median tendon.

When the lower part of the muscle formed by the union of the levator labii superioris and the depressor anguli oris acts alone, it draws the angle of the mouth and the lower lip downward, as in weeping. This muscle also enlarges the mouth transversely by its external fibres. When acting alone it contributes to raise the lower jaw.

(1) *Hist. musc.*, p. 167.
(2) *Obs. anat.*, ch. i., § 25.

j. Depressor labii inferioris.

§ 2060. The *depressor labii inferioris* muscle, *mento-labial*, Ch. (*quadratus menti*), is thin and square. It is covered at its lower part by the preceding, and slightly above by the base of the zygomaticus major muscle; it arises farther forward and lower than the depressor anguli oris muscle, ascends obliquely from without inward towards the lower lip, interlaces and intercrosses with that of the opposite side by its upper and inner part, and terminates in the orbicularis oris muscle.

It draws the lower lip obliquely downward and turns it over.

This muscle and the preceding generally blend with the upper part of the platysma myoides muscle.

k. Levator menti.

§ 2061. The *levator menti* muscle is small, thick, semicircular, and unmated. It is attached on each side to the anterior face of the lower jaw, below the alveolar process of the canine tooth, occupies the triangular space between the two depressor muscles, and terminates in the skin of the chin.

It raises the lower lip and skin of the chin.

II. PALATE.

A. FORM.

§ 2062. The *palate* (*palatum*) forms the arch of the mouth, which it separates from the nasal fossæ. We distinguish in it two portions, an *anterior* or *osseous* portion, and a *posterior* or *soft* portion.

The *osseous* palate is composed of the horizontal or palatine portion of the superior maxillary and palatine bones, and also of the mucous membrane extended on their surface. This membrane incloses a layer of muciparous glands which is much thicker and more complex than that of the two preceding regions.

§ 2063. The *soft palate*, called also the *veil of the palate* (*palatum molle*, s. *velum palatinum*), forms a fold which extends obliquely from above downward and from before backward from the posterior edge of the horizontal portion of the palatine bones toward the base of the tongue. Its lower edge is loose, and presents in the centre a rounded prolongation, termed the *uvula*,(1) on each side of which is a fissure. These two fissured halves of the lower edge form the *inferior arches of the palate* (*A. palatini inferiores*). The *superior arches* (*A. palatini*

(1) Lisfranc, *Considérations anatomiques, physiologiques et pathologiques sur la luette*; in the *Revue médicale*, vol. xi., p. 233.

superiores) are situated a little above. Both are continuous on the median line in the uvula.

The soft palate is formed of two layers of mucous membrane which cover its anterior and posterior faces, and are continuous with the pituitary membrane, of a very dense layer of muciparous glands situated between the two membranes, and of several muscles which contract and vary the form of the isthmus of the fauces (*isthmus faucium*).

A prominence resembling a cicatrix exists along the anterior face of the soft palate and the greater upper part of the uvula; this marks the primitive division of this part into two halves.

B. MUSCLES OF THE SOFT PALATE.

§ 2064. The muscles of the soft palate are distinguished into those which depress it and those which raise it. The first contract the isthmus of the fauces, the latter dilate it.

The muscles which contract the isthmus of the fauces are situated in the two arches; those which dilate it descend from the base of the skull and are directed from without inward.

a. Constrictors of the isthmus of the fauces.

§ 2065. The constrictor muscles of the isthmus of the fauces are two, the *palato-pharyngeus* and the *glosso-pharyngeus* muscles.

a. Palato-pharyngeus.

§ 2066. The *palato-pharyngeus* muscle or the *superior constrictor* of the isthmus of the fauces (*M. palato-pharyngœus*, s. *constrictor isthmi faucium superior*) arises from the upper part of the lateral wall of the pharynx, where its fibres blend with those of the superior and middle constrictors. Thence it enlarges, goes upward and inward, enters the soft palate, divides into an anterior and a posterior layer, which receive between them the levator palati mollis muscle, extends to the posterior extremity of the bony palate, and unites on the median line with that of the opposite side.

It depresses the soft palate.

b. Glosso-pharyngeus muscle.

§ 2067. The *glosso-pharyngeus* muscle, or the *inferior constrictor* of the isthmus of the fauces (*M. glosso-pharyngœus*, s. *constrictor isthmi faucium minor*, s. *inferior*, s. *proprius*), a similar but much smaller muscle, ascends from the root of the tongue in the soft palate before the palato-pharyngeus muscle, with which it unites and arrives

at the lower arch, where it joins with that of the opposite side at the base of the uvula.

It depresses the soft palate, and particularly the uvula.

b. Muscles which dilate the isthmus of the fauces.

§ 2068. There are two muscles also which dilate the isthmus of the fauces, the *levator* and the *tensor palati mollis* muscles.

a. Levator palati mollis.

§ 2069. The *levator palati mollis* muscle (*M. levator palati mollis*, s. *petro-salpingo-staphylinus*), *pétro-staphylin*, Ch., is oblong and almost rounded; it arises from the centre of the anterior edge of the petrous process, and from the osseous portion of the Eustachian tube, and also from the posterior part of the commencement of its cartilaginous portion, by a short and strong tendon, goes inward and downward, enlarges but becomes thinner, and blends with that of the opposite side; it forms in the soft palate between the two layers of the palato-pharyngeus muscle an arch the convexity of which looks upward and the concavity downward.

It raises the soft palate, and extends it transversely.

b. Tensor palati mollis.

§ 2070. The *tensor palati mollis* muscle, *ptérygo-staphylin*, Ch. (*M. tensor palati mollis, circumflexus palati, pterygo-salpingo-staphylinus*), is broad, thin, and quadrilateral. It arises a little inward and forward from the upper extremity of the pterygoid process behind the pterygoid fossa on the inside of the oval foramen of the sphenoid bone; it frequently comes also from a greater or less extent of the posterior edge of the internal layer of the pterygoid process, and from the outside of the cartilaginous portion of the Eustachian tube. It goes inward and downward and becomes a flat tendon, which turns on the hook of the pterygoid process, a mucous bursæ existing between them; it is attached by its anterior edge to the posterior edge of the palatine arch, and always blends with the tendon of that of the opposite side to form the upper part of the soft palate.

This muscle extends the soft palate and draws it outward, and contributes, like the preceding, to dilate the isthmus of the fauces.

c. Palato-staphylinus.

§ 2071. The uvula or the central portion of the palate, the base of which is pointed, is composed of numerous muciparous glands, which are every where surrounded, sometimes by one sometimes by two

muscles, termed the *palato-staphylinus* (*M. uvulæ*, s. *azygos uvulæ*). This muscle is always very long, and descends from the palatine spine and the anterior face of the tendon of the tensor palati mollis muscle. By contracting, it shortens the uvula.

III. TONGUE.

A. NORMAL STATE.

§ 2072. The *tongue* (*lingua*)(1) is the principal organ of taste, and also of speech and deglutition.

We may consider it as the lower part of the cavity of the mouth, and consequently of the alimentary canal, which is considerably enlarged, and which from this fact projects within the cavity.

Its form is oblong, its edges are rounded, and it gradually becomes thin from behind forward.

Its posterior part is termed the *root*, and the anterior part the *point* or *apex*. It extends forward and on the sides much beyond its base of support, so that it is loose in these two regions, which form most of it. Its integuments are uninterruptedly continuous with the buccal membrane, which forms below its point a longitudinal fold of a very firm tissue, which is attached to the centre of the inner face of the lower maxillary bone, fixes the organ more firmly to the part it occupies, and is termed the *frœnum linguæ*.

As the tongue is formed chiefly by muscles, it assists in articulation and deglutition, while on account of its membranes it is the organ of taste.

Its base is formed posteriorly by the hyoid bone.

a. Muscles of the tongue.

§ 2073. The muscles of the tongue(2) may be distinguished into the muscles of the hyoid bone and the proper muscles of the tongue.

(1) M. Malpighi, *De lingua*, Bologna, 1665.—G. Fracassati, *De lingua*.—L. Bellini, *Gustus organon novissime detectum*, Bologna, 1665.—L. Heister, *De lingua sana et ægrota*, Altdorf, 1716.—A. F. Walter, *De lingua humana*, Leipsic, 1724.—J. Reverhorst, *De fabrica et usu linguæ*, Leyden, 1739.—Royen, *De fabrica et usu linguæ*, Leyden, 1742.—J. A. Rinder, *De linguæ involucris*, Strasburg, 1778.—Bauer, *Sur la structure de la langue;* in the *Journal compl. des sc. méd.*, vol. xiv., p. 181.—Gerdy, *Discussions et propositions d'anatomie, de physiologie et de pathologie*, Paris, 1823, p. 19, pl. i. and ii.—Blandin, *Sur la structure et les mouvemens de la langue;* in the *Archiv. gén. de méd.*, vol. i., p. 437.

(2) Isenflamm, *De motu linguæ*, Erlangen, 1793.

a. Muscles of the hyoid bone.

1. Mylo-hyoideus.

§ 2074. The *mylo-hyoideus* musele (*M. transversus mundibulæ*, s. *mylo-hyoideus*) fills the larger anterior part of the space between the two halves of the lower jaw, viz., the two halves of the horizontal portion and the body of the hyoid bone. It is loose outward in nearly its whole extent, and is covered in its centre by the anterior belly of the digastricus muscle of the lower jaw.

It is a triangular and thin musele, the external convex edge of whieh arises from a corrugated line on the inner faee of the horizontal portion of the lower jaw, and proceeds from before baekward and from within outward. It enlarges considerably from before backward. Its anterior fibres are transverse. The posterior are direeted from before backward and from without inward, and proeeed toward those of the opposite side. It deseends from without inward, and unites with the latter on the median line, being separated from it only by a narrow tendinous band which extends from before baekward to the single musele formed by this union. It is attached by the inner portion of its posterior edge to the centre of the anterior face of the middle piece of the hyoid bone.

This muscle supports those of the tongue, whieh rest on it, and also the sublingual gland, compresses the canal of Wharton, and the excretory ducts of the sublingual gland, sustains these parts, and raises the hyoid bone.

2. Genio-hyoideus.

§ 2075. The *genio-hyoideus* musele is situated directly above the centre of the preceding, next to the synonymous muscle of the opposite side. It has the form of a very elongated triangle, and arises from the upper part of the anterior faee of the body of the hyoid bone, goes from behind forward and from below upward, gradually beeomes thinner and rounder as it aseends, and is attaehed to the lower part of the internal mental proeess direetly above the mylo-hyoideus musele. Its anterior and posterior attaehments are by very short, tendinous fibres.

It draws the hyoid bone upward and forward. When this bone is fixed by its depressor museles it brings the lower jaw downward and backward, so that it acts like the digastricus muscle of the lower jaw.

Sometimes it is deficient, or rather it is imperfectly developed, and is replaced by a smaller muscle, which arises from the median tendon of the preceding, and is attached to the digastricus muscle.(1)

(1) Duille, *Var. musc.*, Landshut, 1815, p. 5.

3. Stylo-hyoideus.

§ 2076. The *stylo-hyoideus* muscle (*M. stylo-hyoideus*, s. *levator ossis hyoidei*) is thin, elongated, and rounded. It arises by a short tendon at about the centre of the external face of the styloid process, goes forward, downward, and inward, presents near its lower extremity a fissure for the tendon of the digastricus muscle, and is attached to the anterior half of the external edge of the large horn of the hyoid bone opposite the thyro-hyoideus muscle.

It draws the hyoid bone upward and backward.

It is frequently doubled, which anomaly depends on the presence of a small accessory muscle.

4. Sterno-hyoideus.

§ 2077. The *sterno-hyoideus* muscle (*M. depressor ossis hyoidei*, s. *sterno-hyoideus*) is thin and elongated. It comes from the inner face of the first piece of the sternum and of that of the cartilage of the first rib, and sometimes also from the inner extremity of the clavicle; thence it goes directly upward, in its course approaching that of the opposite side, and becomes thicker and narrower. It is finally attached to the lower edge of the middle piece of the hyoid bone, directly at the side of the median line.

It draws the hyoid bone downward, and as this bone is attached to the lower jaw, when the other is not fixed by its levator muscles, it is also depressed so that it acts on opening the mouth.

Sometimes it blends below with the sterno-thyroideus muscle,(1) or arises from the centre of the clavicle.(2)

5. Omo-hyoideus.

§ 2078. The *omo-hyoideus* muscle, *scapulo-hyoidien*, Ch. (*M. retractor ossis hyoidei*, *omo-hyoideus*, *coraco-hyoideus*), is a very long, thin, and digastric muscle. Its inferior belly arises from the upper edge of the scapula, sometimes also from the small ligament extended over the coracoid fissure; goes upward and forward; between the sterno-cleido-mastoideus and the scalenus anticus muscles it becomes a tendon whence the superior belly arises, which is attached to the middle piece of the hyoid bone on the outside of the preceding, and blends more or less with the stylo-hyoideus muscle.

It draws the hyoid bone downward, backward, and a little to the side. This muscle frequently presents anomalies. It is rarely entirely

(1) Albinus, *Hist. musc.*, p. 202.
(2) Kelch, *Beytrage zur pathol. Anat.*, Berlin, 1714, p. 32.

deficient: we have observed it once, on the left side, without a substitute. Its origin frequently varies. Sometimes the inferior belly is broader, so that it extends to the upper angle of the scapula.(1) Sometimes it arises from the clavicle,(2) and it is then unusually short. In some subjects the lower belly is divided into two heads, to which its simple enlargement is an approximation.(3) One of these heads is sometimes attached to the clavicle.(4) In some cases it unites with the sterno-thyroideus muscle by its superior belly or by a special head.(5) More rarely it is not inserted in the hyoid bone but in the transverse process of the sixth(6) or second? cervical(7) vertebra.

b. Proper muscles of the tongue.

1. Genio-glossus muscle.

§ 2079. The *genio-glossus* muscle (*M. expulsor, attrahens linguæ*, s. *genio-glossus*), the largest of all the muscles of the tongue, arises from the lower jaw by tendinous fibres which are inserted directly above the genio-hyoideus muscle. It is situated against that of the opposite side, which it does not leave because its direction is that of the median line; it goes backward, enlarges much like a fan, and forms the greater inner part of the tongue the whole length of this organ. It also gives off some fibres which go outward, pass on the following muscle, sends several to the upper part of the pharynx, and furnishes a few to the upper horn of the hyoid bone and the epiglottis.

It brings the tongue, the hyoid bone and the pharynx forward.

2. Hyo-glossus.

§ 2080. The *hyo-glossus* muscle (*M. depressor linguæ*, s. *hyo-glossus*, s. *basio-cerato-chondro-glossus*) is thin, and has a long square form. It arises from the outer part of the body of the bone, from the external edge of its great horn, and from the summit of the small horn, ascends toward the lateral part of the tongue, and contributes to form it.

It draws the tongue downward.

(1) Albinus, *Hist. musc.*, p. 200.
(2) Albinus, *loc. cit.*, p. 201.
(3) Duille, *loc. cit.*, p. 11.
(4) Kelch, *loc. cit.*, p. 31.—Sels, *De musc. variet.*, Berlin, p. 6.
(5) Sels, *loc. cit.*, p. 5.
(6) Kelch, *loc. cit.*, p. 32.
(7) Sels, *loc. cit.*, p. 4, 5.

3. Stylo-glossus.

§ 2081. The *stylo-glossus* muscle (*M. retractor linguæ*, s. *stylo-glossus*), the shortest of the small muscles which come from the hyoid bone, arises directly from its summit and also from the upper part of its circumference, and arrives at the root of the tongue, in which it expands like a fan to its point, interlacing more or less with the hyo-glossus and the genio-glossus muscles.

It draws the tongue obliquely backward to its side, and enlarges it when it acts with its synonymous muscle.

We have once found it double on both sides.

4. Lingualis.

§ 2082. The *lingualis* muscle is thin and narrow. It extends from before backward the whole length of the tongue, and interlaces principally with the hyo-glossus and the genio-glossus muscles.

It shortens the tongue, and carries its point backward.(1)

(1) Gerdy has described better than any one before him the lingual portion of the special muscles of the tongue, and has followed them through its whole extent. His conclusions are as follow:

The tongue is composed of a membrane, a peculiar yellow tissue, a superficial lingual, two deep lingual, the transverse lingual, and the vertical lingual muscles, all of which are distinct, of the two stylo-glossi, the two hyo-glossi, the two genio-glossi, the two glosso-staphylini muscles, and the fasciculi of the hyo-glosso-epi-glossus.

The lingual membrane is thick and cartilaginous on its lower surface, in which the subjacent muscular fibres are inserted.

The yellow tissue covers at the base of the tongue the enveloping membrane, which has no cartilaginous texture in this place. It adheres to the hyoid bone, to the epiglottis, and to many muscular fibres. Follicles exist within it.

The superficial lingual muscle covers the upper face and the edges of the tongue, adheres closely to its membrane, and is attached posteriorly to the yellow tissue. Its fibres go forward, some on the upper face of the tongue, converging toward the median line, others above and below its edges to its apex.

The deep lingual muscles are two small fasciculi situated on each side under the posterior two thirds of the tongue, between the hyo-glossi and the genio-glossi muscles. Their fibres are attached posteriorly to the yellow tissue.

The transverse lingual muscles are situated under the superficial lingual, pass through the whole breadth of the tongue and between the lateral fibres of the superficial lingual muscle, which they cross at a right angle, and are attached to the membrane of the tongue under the edge of this organ. They are divided on the median line by a fibro-cellular raphe. They gradually curve more and more towards the base of the tongue.

The vertical lingual muscles extend from the upper to the lower lingual membrane, passing through the whole thickness of the tongue and the transverse lingual muscles, with which they intercross. They curve and become more and more oblique toward the base of the organ.

The fibres of the stylo-glossi muscles blend with those of the superficial lingual muscle above and below the edges of the tongue, and send a transverse fasciculus under the yellow tissue, which unites to that of the opposite side.

The hyo-glossi muscles are situated between the stylo- and the genio-glossi. Their anterior fibres are directed from the hyoid bone very obliquely upward and forward

b. Envelops of the tongue.(1)

§ 2083. The mucous membrane which covers the tongue is characterized principally by the great development of its papillary tissue, and by the facility with which the epidermis is detached from it.

The dermis is united to the muscular membrane more intimately than with the subjacent parts in any other region of the body.

Its upper face is extremely corrugated. The inequalities there observed are:

1st. *Folds.* These folds are seen principally on the posterior part and on the edges of the tongue. They are generally arranged regularly, converge from without inward and from before backward, and are very compact. They are about half a line high and broad. The anterior present numerous transverse grooves. The posterior are smooth, and consequently their surface is less extensive than that of the preceding. Those at the most anterior part of the tongue are less regular and constant. In the middle of the back of the tongue there is frequently a more or less evident longitudinal depression.

2d. *Papillæ.*(2) The papillæ of the tongue are arranged very compactly, and cover almost all its dorsal face. They are insulated only at the root of the organ, where also they enlarge very much.

They vary much in form, and hence have been reduced into several classes.

They are generally small, thin, triangular, and terminated by a blunt or pointed summit.

The latter are very much developed on the centre of the tongue forward and on the edges. They are termed the *filiform papillæ* (*papillæ filiformes*).

Others which are much larger, more distinct but fewer, do not exist in every part, and are enlarged at their loose extremity into a rounded

to about the centre of the tongue. Some of the posterior rise perpendicularly to the base of the tongue; others blend with those of the superficial lingual muscle on the edges of the organ.

The genio-glossi muscles are situated side by side on the inside of the hyo-glossi and the deep lingual muscles: their fibres radiate from the malar process to the three posterior fourths of the tongue, on the median line, to the hyoid bone, the yellow tissue, and the lingual membrane. They pass from below upward through the transverse and the superficial lingual muscle, and curve slightly upward and outward in the thickness of the tongue.

The glosso-staphylini muscles go from the sides of the soft palate on the edges of the tongue, where they blend with the superficial lingual and the stylo-glossus muscle.

The hyo-glosso epiglossus is formed of small fasciculi, generally deficient in man, which go from the hyoid bone to the yellow tissue, others from this tissue to the epiglottis, others also from the epiglottis to the hyoid bone. F. T.

(1) J. A. Rinder, *De linguæ involucris*, Strasburg, 1778.

(2) Albinus, *De diversitate papillarum linguæ humanæ;* in the *Annotat. acad.*, book i., ch. xiv.—Sœmmerring, *loc. cit.*, tab. i., fig. 1-3.

head, whence they are termed the *conical* or *fungiform* papillæ (*papillæ fungiformes*, s. *clavatæ*).

We must however remark, that in this respect they are frequently replaced by single filiform papillæ, which are longer and larger than the others. The fungiform papillæ lead to the largest of the papillæ of the tongue, which are situated at the base of the organ, vary much in number and size, and are arranged in two oblique series, which touch at one of their extremities, and thus form a V, the point of which looks backward. Their form is generally but not always conical, so that they enlarge considerably from their base to their extremity. They are situated in a depression which is continuous with the surface of the tongue by a sack with reversed edges. They are termed the *lenticular papillæ* (*papillæ truncatæ*, *capitatæ*, *circumvallatæ*): they are from three to twenty in number. Each depression commonly contains only one, but sometimes three or four, although this circumstance has no effect on their whole number or on their size. They are not arranged symmetrically, although generally there is one which corresponds very nearly to the median line, and forms the point of the V.

This latter occupies the deepest of all the cavities, that which is termed the *lacuna*, the *foramen cœcum* of the tongue; beside which there is another situated behind it, and which incloses no papillæ.

We have several times thought, but wrongly, that we have discovered in this foramen cœcum the excretory ducts either of the salivary glands or of the thyroid gland.(1)

§ 2084. The papillæ of the tongue appear to the naked eye, and frequently when viewed by the microscope before they are injected, smooth in their whole extent and single; but when their vessels are injected, their surface presents several small asperities, which seem formed by collections of several fasciculi or filaments, placed one against another. This texture is more apparent in the larger and anterior, than in the smaller and posterior part.

Each filament contains at least one vessel; and when well injected, the whole surface of the tongue becomes red. These vessels form very complex arches and plexuses on the surface of the papillæ, since they frequently anastomose, and their loose extremities incline toward each other.

Each filament is also composed of a soft and whitish mass which probably contains nervous substance. At least some filaments of the glosso-pharyngeal nerve have been traced into the posterior papillæ of the tongue, and some filaments of the lingual branch of the fifth pair into the others.

(1) Coschwitz, *De ductu salivali novo*, Halle, 1724.—Refuted by Duvernoy (*De ductu salivali Coschw.*, Tubingen, 1725), and by Haller (*Exp. et dub. circa ductum Coschw.*, Leyden, 1727).

The arrangement of the vessels is more apparent in the anterior than in the posterior papillæ of the tongue, because they inclose proportionally more mucous tissue.(1)

§ 2085. Behind the lenticular papillæ, the surface of the tongue is smooth, presenting only numerous muciparous glands; its sides are also smooth. We only remark on the limit between them and the lower part of the cavity of the mouth, the orifices of the excretory canals of the submaxillary gland.

§ 2086. The tongue is covered in every part, especially on its upper face, by a thick, whitish and moist epidermis, (*periglottis*)(2), which is formed exactly like the papillary tissue, and which consequently presents on its upper face numerous elevations, and on its lower face, which looks towards the papillæ, a corresponding number of rounded depressions, so that at first glance it seems perforated with foramina, although this is not the case.

§ 2087. We have already described the nerves of the tongue, and have given our reasons for thinking the lingual twig of the fifth pair is the principal conductor of the sensations of taste, while the hypoglossal nerve should be considered as only the nerve of motion.

Although the tongue receives many nerves, and although its surface is very sensible, its substance is but slightly so. This explains how it can be very much bruised, or how considerable portions of it may be tied, without giving rise to general nervous affections.(3)

§ 2088. The tongue is the principal organ of taste; it acts also in articulation, and contributes to the first changes of the food in the alimentary canal.

The faculty of taste resides principally at its point, next on its edges, finally at its base, and very slightly or not all in its centre. It however is not the only organ of taste, for the soft palate is sensible, at least to certain tastes, for instance that of bitter substances. Hence why the loss of the tongue is not necessarily attended with that of taste.

The tongue assists also in articulation, inasmuch as several consonants hence termed *lingual*, are formed, or at least articulated more distinctly, by its motions in different directions.

It also contributes to change the food in the mouth by carrying it to different parts of this cavity, so that it becomes perfectly moistened with the saliva, and also prevents its escape from the mouth.

We shall return to this use of the tongue, and shall mention its part in deglutition when describing the pharynx.

(1) Albinus, *De fabrica papillarum linguæ humanæ;* in the *Annot. acad.* l. i. c. xv. tab. 1.—Hewson (*Exp. Inq.*, vol. ii. p. 186.—Sœmmerring, *loc. cit.*, tab. 1., fig. 5–9.

(2) Albinus, *De periglottide et corpore reticulari linguæ;* in the *Annot. acad.* l. i. c. xvi.

(3) E. Home, *Obs. on the structure on the tongue, illustrated by cases in which a portion of that organ had been removed by ligature;* in the *Phil. tr.*, 1805, p. 205–214.

§ 2089. The changes in the tongue during its development are trifling. At first its proportional volume is greater than when the organism is perfect. It is also broader, and is attached to the lower wall of the cavity of the mouth in a smaller portion of its lower face, which resembles to a certain extent the peculiar formation of frogs.

B. ABNORMAL STATE.

§ 2090. Sometimes the tongue does not exist, either from primitive deviations of formation, or from ulcers which have destroyed it.

Its frenum is not unfrequently too solid, too short, or too long. It is rarely bifurcated at its point.

The lenticular papillæ also are rarely entirely deficient, and replaced only by skin destitute of papillæ.(1)

The excess in the size of the tongue is rarely congenital. It is observed more frequently during life after some accident, particularly from metastasis.

In this case a portion of the organ may be extirpated without inconvenience. This phenomenon seems to affect females more frequently than males.

The turning of the tongue backward, which produces suffocation by closing the entrance of the larynx, may be caused by its frenum being entirely divided.(2)

The principal alterations of the texture of the tongue are scirrhus and cancer.

IV. ORAL GLANDS.

A. ABNORMAL STATE.

§ 2091. The *oral glands* (*Gl. orales*) are of two kinds, the *muciparous* and the *salivary* glands.

a. Muciparous Glands.

§ 2092. The *muciparous* glands are distinguished into the *anterior* and the *posterior*.

The *anterior* are more insulated and lenticular. Their greatest diameter is only two lines, and they are found principally in the lips and cheeks, opposite the upper posterior molar teeth, between the buccal membrane and the muscles it covers. They are divided according

(1) Louis, *Mémoire physiologique et pathologique sur la langue*; in the *Mém. de l'ac. de chir.* vol. v., p. 486–520.—Breidenstein, *De morbis linguæ*, Erlangen, 1791.

(2) We doubt whether death is ever produced by this cause, although travelers often speak of negroes swallowing their tongues. Superficial observers have been led into error by a phenomenon which is proved possible by Bourdon's researches, in giving reason to think, that the greatest effort in a robust person would cause death, and thus in some measure one commit suicide. (*Recherches sur le mecanisme de la respiration et sur la circulation du sang*, Paris, 1820, p. 84.) F. T.

to their situation into *labial*, *buccal*, and *molar* (*gl. labiales*, *buccales*, *et molares*). These latter are rarely blended in one mass, the excretory passages of which unite in one.

The *posterior* are the *palatine* glands and the *amygdalæ*.

The *palatine* glands (*gl. palatinæ*) form a continuous layer from one to two lines thick, which covers all the palatine arch and all the soft palate, the posterior face of which they occupy.

The *amygdalæ* or the *tonsils* (*Amygdalæ*, s. *tonsillæ*) are oval bodies, about six lines long, three thick and broad, which exist in the soft palate between the anterior and posterior arches. The fluid they secrete enters the cavity of the mouth through several broad openings, situated on their anterior face.

b. Salivary Glands.

§ 2093. The three *oral salivary glands* (*gl. salivales orales*) which belong to the class of conglomerate glands(1) are situated around the cavity of the mouth and near the lower jaw. They are the *parotid*, the *submaxillary*, and the *sublingual* glands. All secrete a peculiar fluid, the *saliva*,(2) which is one of the most aqueous fluids of the body, and contains a peculiar principle which cannot be coagulated by boiling, by tannin, or by the acetate of lead. We also find in it a white mucous substance, and the common salts of the serum of the blood. It is also remarkable for its great affinity for oxygen.(3)

Beside the general characters of the class to which they belong, these glands also present several common peculiarities, the principal of which are as follow. 1. Their rounded form. 2. Their reddish color. 3. They have no special membranous capsule, are surrounded only by condensed cellular tissue, and are loosely attached to the adjacent parts. 4. They are so situated that they are affected by the mechanical action of the muscles, and even partly by that of the lower jaw when it is moved. 5. The fluid they secrete possesses probably in every part the same properties.

Notwithstanding these general points of resemblance, they differ so much in form, size, texture, situation, and color, that we must describe each of them separately.

(1) N. Stenon, *De glandulis oris et nuper observatis inde prodeuntibus vasis*, Leyden, 1661.—A. Nuck, *Sialographia ductuum aquosorum anatome nova*, Leyden, 1690.—J. B. Siebold, *Historia Systematis salivalis physiologica et pathologica considerati*, Jena, 1797.

(2) G. T. Fischer, *Diss. de saliva physiologice et pathologice considerata*, Breslau, 1817.

(3) Berzelius, *Fortsetzung der thierischen Chemie*, Nuremberg, 1815, p. 47.—John, *Recherches chimiques sur la salive et la liqueur que les ventricules de cerveau renferment dans l'hydrocéphale*; in the *Journ. compl. des sc. méd.*, vol. vi., p. 270.

a. Parotid gland.

§ 2094. The *parotid* gland (*parotis*),(1) is the largest oral salivary gland, and in the adult it usually weighs from four to five drachms.

Its form is irregularly square. It is usually more high than broad, narrower from within outward than in any other direction, and its thickness is much less than its height and breadth. Its lower half is considerably thicker and broader than the upper.

It is situated directly under the skin, before the lower half of the external ear, between the space in the ascending ramus of the lower maxillary bone forward, and backward between the auditory foramen and the mastoid process of the temporal bone.

Its upper extremity, which is also the smallest edge, extends to the posterior extremity of the zygomatic arch, and covers the head of the ascending ramus of the lower maxillary bone. Its smaller anterior half corresponds in its whole extent to the posterior part of the ascending ramus of the lower maxillary bone and of the masseter muscle. The posterior half is larger than the preceding, and fills the space we have mentioned. It covers the petrous portion and the styloid process of the temporal bone, also the external parts of the pterygoidei muscles and the upper part of those which arise from the styloid process. Posteriorly, the gland terminates by nearly a straight edge, which is, however, slightly grooved anteriorly. Its lower extremity descends below the angle of the lower jaw; it is in contact with the posterior part of the submaxillary gland, and with the middle tendon of the digastricus muscle.

The lower straight edge descends obliquely, covers the posterior belly of the digastricus muscle, and also generally a small portion of the upper extremity of the sterno-cleido-mastoideus muscle.

The posterior concave edge is adapted to the lower part of the cartilaginous portion of the auditory passage.

The parotid gland is formed of small, rounded, and distinct granulations.

At about the upper extremity of the middle third of its anterior edge an excretory duct emerges, called the *canal of Steno* (*ductus Stenonianus*)(2) The parietes of this passage are considerably thick in proportion to its capacity, and it proceeds from behind forward and

(1) Murat, *La glande parotide considéré dans ses rapports anatomiques et pathologiques*, Paris, 1803.

(2) Although this term is generally applied to the parotid canal, it is not certain that it was discovered by Steno, and not by Needham or Blaes.—N. Steno, *Diss. de glandulis oris et nuper observatis inde prodeuntibus vasis*, Leyden, 1661.—Id., *Observ. anat. quibus varia oris, oculorum et narium vasa describuntur, noviique salivæ lacrymarumque et muci fontes deteguntur et novum Bilsii commentum rejicitur*, Leyden, 1662.—Needham, *De formatu fœtu*, London, 1667; in the preface.—G. Blaes, *Misc. an. hom. brutorumque fabricam diversam exhibentia*, Amsterdam, 1673.

from without inward directly under the skin and on the masseter muscle. It is generally from three to five lines distant from the lower edge of the zygomatic process. The transverse facial artery and some twigs of the facial nerve accompany it. It passes on the anterior edge of the masseter muscle, penetrates between the fibres of the buccinator muscle, and opens in the lateral walls of the cavity of the mouth opposite the first posterior molar tooth of the upper jaw, consequently before the range of the teeth. Its orifice is single, and presents a warty prominence.

We not unfrequently find an *accessory parotid gland* (*Gl. parotis accessoria*), situated more or less before the normal parotid gland, on the malar bone and the zygomatic arch. This gland never communicates with the proper parotid gland, and sometimes divides into two lobes; it opens by a small passage into the parotid canal. It may be compared with the orbitar gland of several mammalia.

b. Submaxillary gland.

§ 2095. The *submaxillary* gland (*Gl. maxillaris*, s. *submaxillaris*)(1) is but half the size of the parotid gland. It has the form of a rounded triangle. It is thicker below than above, and is situated on a level with the angle of the lower jaw, between its inner face and the body of the hyoid bone.

On the outside it touches the lower part of the inner face of the pterygoideus internus muscle. Forward it sends a small prolongation above the posterior edge and the posterior part of the lower face of the mylo-glossus muscle. It rests inward on the posterior extremity of the anterior belly of the digastricus muscle, posteriorly on the stylo-glossus muscle.

Although this gland is much smaller than the preceding, it is, however, composed of much larger lobes.

The excretory duct, called the *canal of Wharton* (*ductus Whartonianus*), arises from the anterior extremity; its parietes are very thin in proportion to its diameter, and it is larger compared with the size of the gland than the duct of Steno. Its direction is obliquely from without inward and from behind forward; it passes above the mylo-glossus muscle, below and on the inside of the submaxillary gland, on the outside of the upper edge of the hyo-glossus muscle, and terminates by a small verrucous prominence on the sides of the frenum of the tongue, consequently behind the range of the lower teeth.

Farther inward the substance of the gland sends off a prolongation some lines thick, which follows the same direction, but does not extend so high, passes through the inner part of the posterior extremity of the

(1) Wharton, *Adenographia*, ch. xxi.—Van Horne, *De ductibus salivalibus disp. III.*, 1656, 1658.

sublingual gland, and opens at the side of the canal of Wharton, sometimes in common with a small excretory duct which leaves this latter gland. This common duct is called the *canal of Bartholini* (*ductus Bartholinianus*).(1)

c. Sublingual gland.

§ 2096. The *sublingual gland* (*Gl. lingualis*, s. *sublingualis*)(2) is situated before the preceding, so that the posterior extremity touches the anterior extremity of the latter, occupies on each side the whole length of the tongue, and may be found directly under the buccal membrane, through which it is easily felt, and is even visible, on account of its inequalities and prominences. It is situated between this membrane, the myo-glossus, the genio-glossus, the genio-hyoideus, and the hyo-glossus muscles. It is formed like an elongated triangle, and it is nearly as large as the submaxillary gland.

It is composed of smaller lobes than the preceding, is whiter and harder than it, and opens not like the two glands previously described by one orifice, but by several, usually seven or eight; it, however, forms no distinct excretory duct. We perceive these openings on the lower face of the cavity of the mouth on each side below and near the tongue. There are also several ducts from its anterior portion (*ductus Riviniani*), which unite with that of the submaxillary gland; sometimes one only anastomoses with a passage formed by a division of this latter, and thus give rise to the passage of Bartholini (§ 2095).

§ 2097. There are in fact no other salivary glands or other passages which carry saliva. Although several anatomists(3) have admitted others, it has long been proved that the parts considered as such are simply those of the muciparous glands at the root of the tongue or around the larynx, or even of the veins of the back of the tongue.(4)

§ 2098. The oral glands present no differences in respect to their development, except those generally remarked in all glands.

(1) G. Bartholini has discovered it in the lion (*De ductu salivali hactenus non descripto observatio*, Leyden, 1684).

(2) A. F. Walther, *De lingua humana novis inventis octo sublingualibus salivæ viis, nunc ex suis functionibus, glandulis subtingualibus eductis*, Leipsic, 1724. —C. J. Trew, *De vasis linguæ salivalibus atque sanguiferis epistola*, Nuremburg, 1734.

(3) A. Vater, *Novus ductus salivalis, qui in linguæ superficie superiore circa ejus medium notabili orificio hiat*, Wittemberg, 1720.—Id., *Novus ductus salivalis isque præcipuus in lingua excretorius glandulæ insignis ad latera linguæ et sub eadem sitæ itemque super radicem linguæ, epiglottidem, circa glottidem super arytænoideas usque intra œsophagum expansæ*, Wittemberg, 1721.—Id., *De ductu salivali in lingua noviter antehac detecto, nunc dilucidato, confirmato, novisque experimentis adducto, una ductus excretorius tonsillarum ac glandulæ thyreoideæ*, Wittemberg, 1723.—G. D. Coschwitz, *De ductu salivali novo*, Halle, 1724.—Id., *Continuatio observationum de ductu salivali*, Halle, 1729.

(4) Trew, *loc. cit.*

B. ABNORMAL STATE.

§ 2099. The anomalies of the oral glands, generally speaking, present nothing peculiar.

Primitive deviations of formation are very rare.

We must, however, mention as such the abnormal union of the parotid and submaxillary glands.

These organs, particularly the parotid canal, are easily wounded; this causes the saliva to flow outward, and thus forms salivary fistula.

The closing of the orifice of the excretory canal of the submaxillary gland is often at least the cause of *ranula*, although this affection depends very frequently on a newly-formed cyst.(1)

Simple enlargement is rare. The swelling of the parotid gland in inflammation is situated in the cellular tissue between its lobes.

So too the general alterations of texture, as scirrhus and cancer, which are also attended with an increase of volume, generally occur not in the glandular tissue, but in the lymphatic glands, which are situated on the inside and below the salivary glands, since the glandular tissue is generally unaffected in this case.(2)

The tumors developed in the lower jaw are also situated in the lymphatic glands of the neck. Sometimes we meet here, as in other parts of the system, accidental ossifications with formations entirely abnormal.(3)

Calculous concretions are formed in the amygdalæ and the salivary passages, especially in the excretory ducts of the submaxillary gland. These calculi are composed, according to Fourcroy,(4) of an animal matter and of phosphate of lime. If however we may judge from external characters, a salivary calculus described by us(5) seems more similar to those biliary concretions which have cholesterine for their base.

The calculi developed in the amygdalæ are of a dirty white color. The disagreeable odor which they generally possess probably depends,(6) at least in great part, on the decomposition of animal matter which surrounds them and enters into their composition; for frequently this matter alone is very disagreeable, and, like the forma-

(1) Breschet, *Considérations sur la tumeur nommée communément ranule ou grenouillette;* in the *Journ. univ. des sc. méd.*, vol. viii., p. 296.
(2) Burns, *Anatomy of the head and neck*, p. 270.
(3) Burns, *loc. cit.*, p. 283.
(4) *Syst. des conn. chim.*, vol. ix., p. 312.—John has found nothing else in two salivary calculi, one of which come from the tissue of the parotid gland: *Chemische Zerlegung einer Concretion der Parotis;* in the *Deutsches Arch. für die Physiologie*, vol. iv., p. 602: *Chemische Zerlegung einer Speichelsteins;* same journal, vol. vi., p. 603.
(5) *Handbuch der pathologischen Anatomie*, vol. ii., pt. ii., p. 467.
(6) Burns, *loc. cit.*, p. 265.

tion of the calculi of which we are speaking,(1) depends on a derangement of the digestive function.

V. TEETH.

§ 2100. The teeth (*dentes*)(2) are the hardest parts of the body. In their chemical and physical properties they resemble the bones, but they differ from them in their mode of union with the body, in their mode of development, and in their vital phenomena. In all these respects they are more similar to the epidermoid parts, particularly the nails and hairs.

A. NORMAL STATE.

a. Perfect state.

§ 2101. 1st. *Situation.* The teeth are inserted in most of their extent in the alveolar processes of the two jaws, which closely embrace them, and articulate with them by gomphosis. The portion in the alveolar process is termed the *root* (*radix dentis*). The rest of the tooth is not free. The centre, which is the smallest part, is termed the *neck* (*collum*, s. *corona dentis*), and is surrounded by the gum; all the portion above projects, and is exposed in the cavity of the mouth; this is the *body* or *crown* of the tooth (*corpus*, s. *corona dentis*).

(1) Burns, *loc. cit.*, p. 265.

(2) Treatises on the teeth generally treat of their anatomy, physiology, pathology, and therapeutics, and differ only by speaking more at length on one of these heads. We mention several works almost entirely pathological, as many of them contain a number of special or general remarks in regard to their anatomy and physiology: Eustachius, *De dentibus libellus*, Venice, 1563.—B. Martin, *Dissertation sur les dents*, Paris, 1679.—A. C. G. Cumme, *Diss. sist. dentium historiam*, Helmstadt, 1715.—P. Fauchard, *Le chirurgien dentiste, ou traité des dents*, Paris, 1728.—Lecluse, *Nouveaux élémens d'odontologie*, Paris, 1754.—Bourdet, *Recherches et observations sur toutes les parties de l'art du dentiste*, Paris, 1757.—Curtis, *A treatise on the structure and formation of the teeth*, Oxford, 1769.—F. X. de Wasserberg, *Aphorismi anatomico-physiologici de dentibus*, Vienna, 1770.—J. Hunter, *Natural history of the human teeth*, London, 1778.—H. G. Courtois, *Le dentiste observateur*, Paris, 1775.—Broussonet, *Considérations sur les dents en général et sur les organes qui en tiennent lieu*; in the *Mém. de l'ac. des sc.*, 1787, p. 550.—A. G. Berger, *Diss. de dentibus*, Kiel, 1788.—S. H. Bring, *Observationes in hodiernam de dentibus, præcipue hominum, doctrinam*, Lund, 1793.—F. Hirsch, *Praktische Bemerkungen über die Zahne*, Jena, 1801.—R. Blake, *Essay on the structure and formation of the teeth in man and various animals*, Dublin, 1801.—J. Fox, *Hist. nat. et maladies des dents de l'esp. humaine*, Paris, 1821.—A. Serres, *Essai sur l'anatomie et la physiologie des dents, ou nouvelle théorie de la dentition*, Paris, 1817.—F. Lavagna, *Esperienze e riflessioni sopra la carie dei denti*, Genes, 1821.—Heilbronn, *Diss. de dentibus*, Berlin, 1821.—C. G. Kaathover, *De dentium formatione atque natura*, Leyden, 1821.—J. Lemaire, *Traité sur les dents*, Paris, 1822.

The root and neck of the teeth are covered with a thin membrane; this is continuous below with a nervous and vascular tissue which fills the cavity of the tooth, and above with the gum; it is termed the *dentar periosteum*, although the history of dentition seems to demonstrate that its relations with the teeth are not the same as those between the periosteum and the bones.

The alveolar processes are also covered by a fibrous and thick membrane, which in the normal state does not unite with the preceding, but is continuous with the upper part of the gum, and is termed the *alveolar periosteum.*

The *gums* (*gengivæ*) are a firm, resisting cellular tissue about half a line thick, which adhere intimately with the buccal membrane, and receive but few vessels or nerves. They cover the neck of the teeth, and also the two faces of the alveolar edges of the jaws, and furnish thin prolongations which extend between each two teeth, from the anterior to the posterior face.

The teeth of each jaw collectively form an arch which is concave backward and convex forward.

They are generally arranged very compactly, and are placed at equal distances from each other. The upper and the lower touch at their summits. The arch formed by the upper teeth is a little longer than the other. Hence the upper teeth slightly project outward, and the anterior, which are thinner, cover the others. The posterior and inferior teeth have their summits slightly inclined inward, while those of the upper are turned more directly downward.

2d. *Form.* All the teeth are more or less elongated; their lower extremity is slightly pointed, and there presents a small opening which leads into the *cavity of the tooth* (*cavum dentis*). This cavity extends from the summit of the roots to the crown, and is very narrow in proportion to its length, represents the form of the tooth, and lodges its vessels and nerves, which are connected by cellular substance.

3d. *Number.* The number of the teeth is the same in the two jaws, on the two sides, and in the two sexes. In a well developed man there are thirty-two.

4th. *Texture.* The tissue of the teeth is very hard and solid. They are composed of two substances, the *osseous substance* and the *enamel.*

§ 2102. The *osseous substance* or the *ivory* forms the largest part of the tooth, the root, the neck, and almost all the crown. It consequently represents the form of the whole tooth. Its hardness, which exceeds that of the bones, depends upon its mechanical arrangement and on its chemical composition. In fact it contains no cellules. We perceive in it but not very clearly only longitudinal layers, situated one upon another from without inward, and it contains more of lime than the other bones. Berzelius asserts(1) that one

(1) Gehlen, *Journ. fur die Chimie und Phys.*, vol. iii., part i., p. 19.

hundred parts of this substance contain 51.04 of phosphate of lime; 2.00 of fluate of lime; 11.30 of carbonate of lime; 1.16 of phosphate of magnesia; 1.20 of soda; and an indeterminate quantity of hydrochlorate of soda. Pepys states that they contain 0.64 of phosphate of lime; 0.6 of the carbonate; 0.20 of gelatine; and 0.10 of water, including the loss.(1)

§ 2103. The *enamel* (*substantia vitrea*)(2) is milk white, brilliant, semitransparent, and still harder and firmer than the osseous substance. It covers all the crown of the tooth, is molded exactly upon it, and preserves all the inequalities of its masticating surface, where it is thickest. It gradually grows thinner towards the neck. It is composed of oblique, undulating, serrated bands, concave upward, convex downward, which are arranged compactly from above downward, and exactly fit to each other.(3)

The enamel contains still more of earthy salts than the osseous substance. We find in it, according to Morichini:(4) 0.33 of lime; 0.09 of magnesia; 0.05 of alumina; 0.22 of fluoric and phosphoric acids; 0.01 of carbonic acid; and 0.30 of animal substance.

According to Hatchett(5) it contains very little of gelatine, and is mostly formed of phosphate of lime.

Foucroy and Vauquelin(6) state that it is composed of 72.90 of phosphate of lime, and 27.10 of gelatine and water.

Pepys asserts(7) that it is formed of 0.78 of phosphate of lime; 0.60 of the carbonate; and 0.16 of water.

Finally, Berzelius(8) mentions as its component parts: 85.3 of the phosphate; 3.3 of the fluate; 8.0 of the carbonate of lime; 1.5 of the phosphate of magnesia; and 2.0 of animal substance and water.

§ 2104. The vessels and nerves of the teeth are proportionally very large. The first arise from the internal maxillary artery; the nerves come from the second and third branch of the trifacial nerve, penetrate through the openings at the summit of the roots, correspond perfectly to them in number, descends into the cavity of the tooth, where, united by cellular tissue, they form the *nucleus* or *pulp of the tooth* (*pulpa*, s. *nucleus*). These nerves enlarge near the neck of the tooth,

(1) Fox, *loc. cit.*
(2) Ludwig, *De cortice dentium*, Leipsic, 1753.—Schreger, *Uber den Zahnschmelz;* in Rosenmuller and Isenflamm, *Beyträge zur Zergliederungskunst*, vol. i., part i.
(3) Cumme, *loc. cit.*, p. 9.—Schreger, *loc. cit.*
(4) *Analisi dello smalto di un dente di elefante e dei denti umani;* in the *Memoire della societa italiana*, vol. x., pt. i., p. 162; vol. xii., pt. ii., p. 73.
(5) *Phil. trans.*, 1799.
(6) *Mém. de l'Institut.*, vol. ii., p. 283.—*Annales de chim.*, vol. lv., p. 265; vol. lvii., p. 37.
(7) *Loc. cit.*
(8) Gehlen, *Journ. für phys. und Chem.*, vol. iii., part i., p. 27.

become soft and reddish, and seem covered with a network of vessels.(1)

§ 2105. These characters are common to all the teeth; but there are others in respect to which they differ, and hence they may be divided into several classes.

They differ from each other in several respects, but principally in regard to:

1st. Their situation.

2d. Their form.

3d. Their duration.

4th. The period of life at which they appear.

§ 2106. In respect to *situation*, the most general difference is that which exists between the teeth of the upper and those of the lower jaw. The latter differ from the former in being a little smaller, so that the curve represented by their union is narrower and shorter; hence the upper row of teeth projects a little beyond the lower in every part.

§ 2107. The teeth of the same jaw differ from each other in *form*; hence their division into three classes, the *incisors*, the *canine*, and the *molar* teeth.

§ 2108. The *incisors* (*dentes incisivi*, *incisores*, *primores*) are eight in number, four in each jaw, occupying the most internal and the most anterior part. They differ most from the others in the form of their crown. The latter is chisel-shaped, and becomes much thinner from the neck to the summit, which presents the cutting surface. The posterior face is very concave and the anterior is convex, but not in the same proportion. The incisors begin to become extremely thin from their centres. In the perfect state, when they have not been used for mastication, their edge is divided into a middle and two lateral small grooves; but these grooves soon disappear, and the summit of the tooth then forms only a thin straight line, which extends the whole breadth of the crown.

These teeth have but one root. It diminishes imperceptibly from the crown to its extremity. A depression not unfrequently exists its whole length on each side, indicating the division of this root into two halves, an anterior and a posterior; and even the summit is divided into two small grooves, an anterior and a posterior.

The incisors differ from the other teeth in their direction; they are situated more transversely, so that their loose face looks forward; the other is turned backward, and their cutting edge extends from one side to the other.

§ 2109. The incisors also differ much from each other. The difference between the synonymous teeth of the two jaws is no where so striking as in them, even when they are most similar in size. Those of the upper jaw, however, extend half a tooth farther outward than

(1) Serres, *loc. cit.*, p. 52.

those of the lower jaw. The superior are twice as large as the inferior.

The incisors of the lower jaw differ also from the others both in size and form. In fact they all have a chisel-like form, and their external edge is about as high as their internal. Sometimes, even, they are all similar in this respect. But most commonly their external edge descends a little lower than the internal, and is continuous with the other by a rounded angle.

The internal inferior incisors possess this form very seldom, and the others very generally. In the external superior incisors the internal edge is a little convex outwardly, and is insensibly continuous with the lower, although a little farther downward, so that the cutting surface is narrower than the greatest breadth of the tooth.

These differences in form deserve notice, as they establish the gradual transition from the internal inferior incisors to the canine teeth through the medium of the others.

In respect to the size, the inner pair of incisors in the upper jaw are a little and often much larger than the outer; while in the lower jaw the incisors are about the same size, or the outer pair is a little larger than the inner.

§ 2110. Next to the incisors come the four *canine* teeth (*dentes canini*, *ferini*, *cuspidati*), one on each side. Their crown is much thicker from before backward than that of the incisors, but it does not diminish as rapidly from above downward; hence why their summits are less cutting. This summit is also pointed, because the lower face does not describe a straight line, as the two lateral faces terminate higher than in the incisors, and as the crown of the canine teeth is as elevated as that of the latter, it follows that the lower face is composed of two parts which unite in the centre at an acute angle. Consequently the crown is more rounded and more conical; it extends both inward and outward above that of the incisors. On the posterior face we perceive from above downward in the centre a slight prominence, between which and the edges there is a small depression. This arrangement is more evident in the inferior than in the superior canine teeth.

Of all the teeth the canine have the longest roots. These roots are single and pointed. We generally observe in them the groove mentioned when speaking of the external incisors.

§ 2111. In the posterior part of the jaw are the twenty *molar teeth* (*dentes molares*), ten in each jaw, five on each side. They are similar to each other, and differ from the other teeth:

1st. In the greater breadth of their triturating surface, which depends on the fact that the posterior face of the crown does not descend obliquely to meet the anterior, but is parallel with it.

2d. In the square or rounded form of this surface generally.

3d. In the considerable elevations and depressions in this triturating surface.

4th. In the lowness of their crown.

5th. In the division of their roots into several distinct branches, or at least they are much more distinct than any other teeth where this division is only indicated.

§ 2112. Notwithstanding this general similarity they differ very much, particularly the two anterior and the three posterior. The first are termed the *small molar* or *bicuspid* teeth (*molares anteriores*, s. *minores*, s. *bicuspidati*), and the others, which are larger, the *great molar* or *multicuspid* (*molares posteriores*, s. *majores*, s. *multicuspidati*).

§ 2113. The small molar teeth differ from the great:

1st. By their smallness. They are at least one half smaller.

2d. By their compression from one side to the other.

3d. By their triturating surface, which is less uneven.

4th. By the form of their roots. The latter are at most bicuspid, and even when they assume this form they are so only in the part farthest from their crown, that is, they never present as deep a fissure as the posterior molar teeth. In most cases they are broader from within outward than those of the incisors and the canine teeth, are terminated by a blunter summit, and their lateral grooves are more superficial.

The triturating surface of the small molar teeth generally presents two eminences, one anterior and external, the other posterior and internal. From this they take their name. This arrangement is more evident in the upper jaw, because the two eminences are there separated by a deep transverse groove. In the lower jaw the eminences of the small molar teeth are, on the contrary, united by a crest, the direction of which is from without inward. This difference deserves notice, because the canine teeth of the two jaws (§ 2110) differ from each other in the same manner. The external anterior eminence is always higher than the internal, particularly in the first small inferior molar tooth, where the internal is but slightly developed, and which, in these two respects, evidently makes the transition from the canine to the other molar teeth.

But this is not true of the second small anterior molar tooth. In this we usually observe, behind the posterior eminence, a smaller and more prominent tubercle, or sometimes the posterior eminence is divided into two equal halves. At the same time the external is lower, the crown and the triturating surface are still more rounded, so that this tooth evidently makes the transition from the anterior to the posterior molar teeth; it is also a little larger than the internal.

The small superior molar teeth are more similar to the large than the inferior are, on account of the greater development of their posterior tubercle.

§ 2114. The three posterior molar teeth generally present four blunt tubercles, two on the outside, and two on the inside, which are separated by a crucial depression. But we usually observe also between the posterior two, on the edge of the triturating surface, a fifth, which

is smaller. These tubercles are also rough. The external prominences are generally the largest and most numerous, and frequently the internal tubercle is single, especially in the last two molar teeth. The last great molar tooth is usually the smallest, and the first the largest.

Most generally the roots of these molar teeth present three branches, into which they frequently divide near their crown. The last, it is true, generally has but one root, but this root is never as pointed as in the canine tecth and the incisors, and it always presents at least two very deep and very broad grooves, which indicate a tendency to divide. Sometimes also the other two great molar teeth have only two branches at their root; but in this case one of the branches is always much broader than the other, and also presents a broad and deep groove. In some subjects this broad unmated branch bifurcates below into two small points. The branches of the roots of the molar teeth are usually more curved than the simple roots of the incisors and canine teeth; they begin by separating from each other; they then converge more or less at their lower extremity, where they even touch each other, and blend together at their summits, so that they intercept between them a portion of the upper maxillary bone.

§ 2115. The characters which we have mentioned are those by which we distinguish the teeth which remain in the jaws during most of life. But there are other different teeth which exist but a short time, in youth, and are termed the *deciduous*, or *milk teeth* (*dentes decidui*, s. *infantiles*, s. *lactei*), in opposition to the first, which are termed the *permanent* tecth (*dentes permanentes*).

The teeth which appear at first do not continue during life; many of them remain only till the seventh year, and at the fourteenth year all are replaced by new permanent corresponding teeth.

§ 2116. The two classes of teeth differ from each other in number and form.

In the first respect, we ought not to find more than two molar teeth in each half of the jaw, during the period of the deciduous teeth, whence there are only twenty deciduous teeth, while there are thirty-two permanent teeth.

In respect to form, we distinguish also among the deciduous teeth, the incisors, the canine, and the molar teeth. The incisors and the canine teeth resemble the permanent teeth in form, number, and situation; but all the deciduous teeth, and particularly the molar teeth, differ from their corresponding permanent teeth.

1st. Their crown is much stronger in proportion to their root.

2d. They are less elevated.

All do not present the same peculiarities in respect to size. The deciduous incisors and canine teeth are much smaller than the permanent teeth, particularly in the lower jaw. The contrary occurs in the molar teeth; they come immediately after the canine teeth, the two small anterior molar teeth replace them, and the three molar teeth behind them are permanent. Hence the small anterior molar teeth among the permanent teeth are those which correspond to the decidu-

ous molar teeth at least in respect to situation. But the latter are much larger ; they have not the same form as the small permanent molar teeth, for instead of being flattened from before backward, they are extremely broad, have a broad square crown, and also several, usually five tubercles, which are arranged around a very deep median groove. The anterior is nearly one half smaller than the posterior, although the posterior is almost as large as the largest of the permanent teeth. Besides, they have always at least two and usually three roots. Thus they correspond to the permanent small molar teeth only in number and situation, for in respect to size and form, that is, in two respects much more important than the two preceding, they are analogous to the three permanent great molar teeth.

b. Differences depending on development.(1)

a. General remarks.

§ 2117. The teeth pass through several periods, during which perhaps they differ more than any other part of the body.

The history of their development presents several very curious phenomena. The most essential points to consider, are their mode of development, the period at which they appear, and their changes during life.

1st. The teeth are developed in small rounded and close sacs, which adhere very closely to the gums. These sacs are composed of two membranes. Hunter thinks that the internal alone is vascular, while Black admits this only of the external. But we have ascertained

(1) Besides the works mentioned previously, which also treat on this subject, we may consult the following : J. J. Rau, *De ortu et generatione dentium*, Leyden, 1694. —J. A. Ungebauer, *De dentitione secundâ ;* in Haller, *Coll. diss.*, vol. vi.—J. G. Jancke, *De ossibus mandibularum puerorum septennium*, Leipsic, 1751.—B. S. Albinus, *De dentium ortu ét incremento ;* in *Annot. acad.*. vol. ii. ch. ii., *Quot dentes mutet puer, et quos*, ibid., ch. iii., *De dentium mutatione*, ibid., ch. i.—Jourdain, *Essai sur la formation des dentes comparée âvec celle des os, suivi de plusieurs expériences sur les os et sur les parties qui entrent dans leur composition*, Paris, 1766.—A. A. Brunner, *De eruptione dentium lacteorum ;* in Wasserberg, *Opp. min., fasc. I*, Francfort, 1775. —M. Girardi, *De re anatomicâ oratio*, Parma, 1781, tab. i.—Andree, *De primâ puerorum dentitione*, Leipsic, 1790.—Léveillé, *Mémoire sur les rapports qui existent entre les premières et les secondes dents, et sur la disposition favorable de ces dernières au développement des deux mâchoires ;* in the *Mém. de la soc. méd. d'Emul.*, vol. viii., Paris, 1811.—Miel, *Quelques idées sur le rapport des deux dentitions et sur l'accroissement de la mâchoire dans l'homme ;* same journal.—Duval, *Mémoire sur la position relative de l'ouverture externe du canal maxillaire, pour servir à la démonstration de l'accroissement de la mâchoire inférieure*, Paris, 1812.—J. F. Meckel, *Essai sur le développement des dents chez l'homme ;* in the *Journ. compl. des sc. méd.*, vol. i. p. 365.—Miel, *Note sur la manière dont les dents sortent des alvéoles et traversent les gencives ;* in the *Journ. de méd.*, vol. xxxix. p. 235.—J. E. Oudet, *Observation d'une altération de la racine d'une dent canine, présentant les caractères extérieurs de la maladie des os, connue sous le nom de spinu veniosa, précédée de quelques considérations générales sur la phys. dentaire ;* in the *Archiv. gén. de méd.*, vol. i., p. 340.—Geoffroy Saint Hilaire, *Système dentaire des mammifères et des oiseaux, embrassant sous de nouveaux rapports les principaux faits de l'organisation dentaires chez l'homme*, Paris, 1824.

from examining the human fetus, and those of animals, and Fox has also determined that these two membranes receive vessels ; the blood, however, seems to flow more abundantly to the external than to the internal. A serous fluid exists between these two layers, and the distance between them is much greater the younger the fetus is, although the layers themselves are more difficult to demonstrate than in fetuses of a certain age, on account of their extreme smallness.

The external layer is more spungy, looser, thicker, and softer, than the internal. It is very distinctly continuous with the gum, whence it is easy, in the fetus, especially during the early months of pregnancy, to extract the alveoli attached to the gum.

The internal layer is harder, but thinner than the external. We can demonstrate that it forms a sac entirely distinct from the external and from the gum. Its relations with the teeth are more intimate than those of the external layer, for it is the proper organ of formation. The vessels of the teeth are distributed there much more evidently, and when injections succeed, it appears entirely red.

2d. The small sacs or follicles appear very early. About the tenth week we observe very distinctly in each half of the two jaws, four, two anterior which are smaller, and two posterior which are larger ; they are arranged very compactly in pairs, but the anterior and the posterior are separated by a considerable space. At the end of the third month we find a third sac between the two pairs, and thus at this period the whole number of follicles is twenty. We generally discover at the end of the fourth month, a sixth, situated entirely backward, and which is destined for the most anterior permanent molar teeth.

3d. At first these small sacs contain only a reddish fluid, which afterwards becomes yellowish white. After a certain time, at the fourth month of pregnancy, a small reddish and soft body rises from the base of the internal membrane ; this gradually becomes more consistent, and forms the *germ* or *pulp* of the tooth (*pulpus dentis*). Numerous vessels and nerves given off from the base of the inner membrane, are distributed in this small body, which seems to be enveloped by a vascular membrane, which is difficult to be detached from its own proper substance. It is at first very low, is single in every part, and terminated by a rounded summit ; but it soon assumes the peculiar form of each kind of tooth, and presents its exact image, and is, in fact, the nucleus around which the tooth is molded. The latter is so developed that the loose portion appears first, and presents all the depressions and the eminences which exist upon it, while the rest is not yet formed.

The teeth begin to ossify about the middle of pregnancy. On the loose face of the germ very delicate, thin, and elastic small points first appear ; these are primitively soft, but gradually become thicker and more consistent. These points are grooved and very slightly elevated. They are seen first on the most prominent part of the germ, and represent the tubercles of the future tooth. One is developed on each prominence of the pulp of the tooth ; they gradually unite with each

other; they begin to develop themselves only when a portion of the region of the germ corresponding to the crown is formed, and embrace that part of the pulp, which they cover so closely that some exertion is necessary to separate them. Their internal face and the external face of the germ are, however, perfectly smooth. The difficulty in separating them depends only on the exact manner in which they are fitted to the latter, since by removing one scale, we can extract the whole germ through the space thus formed. Hence, it is very probable that there is no organic attachment between the pulp and the osseous substance, so that these two parts of the tooth are united by vessels, by cellular tissue, or by some other analogous substance. But it is very curious that the germ is redder in the parts covered by the osseous substance, and that the progress of this redness is in direct ratio with that of ossification.

The points soon enlarge, so that they are much thicker in the parts first developed, that is, on the triturating surface. They become much thinner posteriorly, where they are much softer. The crown gradually enlarges, and its development is finally completed. Its lower extremity contracts and becomes the neck of the tooth. The roots are prolongations of the crown, in forming which the germ follows precisely the same course as in giving rise to the latter. The number of the roots, even when the germ has formed only the crown of the tooth, is indicated by that of the distinct branches given off by its vessels.

The osseous substance forms from without inward, so that the small tubercles which first appear are also the parts which always remain exposed, and the triturating surface, like the existing portion of the tooth, has already its normal volume, while it is still very thin, and its internal cavity is very large. This phenomenon demonstrates, undoubtedly, that the bony portion of the tooth is not formed by the inner face of the capsule, but by the external face of the germ, since if this were not true, the opposite arrangement would exist. This osseous portion gradually thickens, and the pulp and the dental cavity diminish in the same ratio, although we cannot suppose that the germ ossifies.

Shortly after the development of the osseous points, or during their formation, the secretion of the enamel commences, by the inner face of the inner fold which surrounds the crown of the tooth, so as to be perfectly molded upon its prominences and depressions. The fluid exhaled by this membrane deposits the enamel on the osseous substance, which is so soft, and adheres so slightly to this latter in the full grown fetus, that they may be very easily separated. It can be detached also, even in the perfect state, from the influence of certain causes, among others, by the action of heat. We discover no special gland for its secretion. It may, however, be easily separated from the prolongations of the internal layer. These prolongations which arise from the portion of the capsule attached to the germ, are at first very thick and moist; they gradually disappear as the enamel forms, so that we may consider them as the germ of this production, and similar

to that which arises from the bottom of the capsule to secrete the osseous substance of the tooth.

The different kinds of teeth do not ossify after the same type in respect to time and form. The internal incisors are the first, and the posterior molar teeth the last to appear. In regard to the intermediate teeth, the deciduous teeth differ from the permanent teeth. The incisors and the canine teeth arise by one small point, and the molar teeth by several, viz. the small by two, and the large by four or five. Each point always possesses a thin triangular form on its appearance, which is the constant form of the crown of the canine tooth. In the incisor and molar teeth these points extend, and those of the incisor teeth present two small accessory points, which do not arise by special nuclei. Among the different points of the canine teeth the external and the anterior are developed the first, and next the internal. In the large posterior molar teeth the anterior external is first seen, then the anterior internal, and the two points of the first posterior form in the same order. The different points unite according to the same law, so that judging from their development, the large molar teeth seem to be formed by two smaller teeth.

The inferior arise or are developed before the superior. The points of the anterior deciduous molar tooth are already united to the lower jaw in the full grown fetus, while this is not the case in the upper jaw. In one case where the first inferior permanent molar tooth presented five osseous points, there were only three in the superior.

§ 2118. When is the formation of the tooth completed? It is not certainly when it appears, since the tooth cuts through the gum before it is perfectly developed; but we have now to inquire if the tooth undergoes any other internal changes after the root is perfectly formed.

Those who maintain this fact adduce the following arguments:

1st. The change in the tooth in animals fed with madder.

2d. The projection of one tooth above the rest, when the corresponding tooth in the opposite jaw is extracted.

3d. The union of fractured teeth.

The following arguments have been adduced in favor of the continual reproduction of the enamel:

4th. The pathological changes in this substance, particularly the black spots, which do not reappear after being removed until a new disease supervenes.(1)

5th. The duration of the enamel, which cannot be explained when we consider the continual friction of the teeth, except by admitting it is constantly forming.(2)

The following are objections to these different arguments:

(1) Hirsch, *loc. cit.*, p. 17.
(2) *Ibid.*

1st. The coloring of the bones generally by madder does not prove that their substance is constantly reproduced.(1)

2d. Probably we have less right to admit an increase in the size of the tooth than its expulsion from the alveolar process. Beside the phenomenon to which it alludes does not occur in man or in most mammalia, although observed in some of them, particularly the gnawers,(2) the teeth of which project after being extracted or cut off.

3d. The union of fractures of the teeth does not prove that their substance is continually reproduced, but only that in some cases the germ of the tooth can restore a fractured part by a process analogous to that, when at the commencement it secretes the osseous substance in every part.

4th. It is nowhere proved that the enamel is formed again in the pathological cases adduced.

5th. The duration of the enamel depends on its solidity.

Thus the arguments in support of the continual formation of the teeth in general, and particularly of the enamel, are by no means conclusive. On the contrary the second fact contradicts it. Beside the mode in which the enamel is developed does not admit this theory.

§ 2119. Beside the whole duration of pregnancy, a long time advances, usually six months after birth, before the teeth appear, at least externally.

During this period we find in the place afterward occupied by them, a very hard and in fact a cartilaginous mass, which projects and presents numerous grooves some lines deep and entirely different from the gum; this arises above the surface of the alveolar edges and fulfills the function of the teeth, that is, it serves principally to retain the nipple.

This substance may be called the *dental cartilage* (*cartilago dentalis*). It is worthy of notice as analogous to the horny beak of birds and reptiles. It disappears as the teeth are developed and perforate the gum.

We discover in this substance, particularly in the region of the molar teeth and on its inner and concave side, several follicles of different sizes, containing a shining and yellowish substance; these are at most but half a line in diameter, and apparently have no external orifice. Serres first mentions these follicles.(3) He thinks that they soften the gum of the child before the teeth appear, and afterwards secrete the tartar of the teeth. We however have never observed them until the period when the teeth appear, so that hitherto we have considered

(1) B. Gibson, *On the effect of madder-root on the bones of animals;* in the *Mem. of the literary society of Manchester, 2d series,* vol. i., p. 146–164.

(2) Lavagna, *Osservaz. sulla carie dei denti,* Genoa, 1812.—Oudet, *Expériences sur l'accroissement continu et la reproduction des dents chez les lapins, considérées sous le rapport de leur application à l'étude de l'organisation des dents humaines;* in the *Journ. de phys. expér.,* vol. iv., p. 70.

(3) *Loc. cit.,* p. 28–33, pl. 4, f. 6.

them simply as new formations, caused by the irritation of the teeth which are soon to appear; they probably do not differ in their nature from abscesses.

§ 2120. The triturating surface of the permanent teeth, like that of the deciduous teeth, changes more or less during life. The enamel is gradually used by friction so that the osseous substance is exposed, and the triturating substance, formed at first entirely of enamel, presents only a layer of osseous substance when the cutting edges and the pointed summits of the crowns are blunted. When the tooth is still more worn, so that the osseous substance is destroyed to the dental cavity and the latter is open, there is generally formed in the same proportion at the summit of this cavity a brownish substance resembling bone, but a little softer, which closes the opening and protects the parts within the cavity.(1) These phenomena can also be adduced against the opinion of those who assert the continual reproduction of the enamel.

Nutrition however gradually declines in the teeth, and their nutritious foramina are finally obliterated. Being retained in the alveolar processes by no organic attachment, they become loose and fall out. The alveolar processes collapse and the alveolar edge entirely disappears after the gum has closed the alveolar openings.

b. Special remarks.

§ 2121. The different kinds of teeth do not pass through the different periods generally mentioned in the same time, but very irregularly and more or less in succession. We may mention generally:

1st. That they pass through the different periods after the same law, so that the germ of the tooth in which the follicle first appears is also the first to be developed and ossified.

2d. That the synonymous teeth in the same jaw correspond very exactly in this respect.

3d. That the lower teeth are developed before the upper, and the anterior before the posterior.

4th. That the gradual development of the human teeth corresponds to permanent forms in the mammalia.

1. Deciduous teeth.

§ 2122. The deciduous teeth, in accordance with the first law, appear sooner than the permanent teeth. The period at which their follicles are developed and the order in which these latter are seen have

(1) Hunter, *loc. cit.*, p. 108.—Prochaska, *Obs. de decremento dentium;* in the *Annot. acad., fasc. I.*

already been mentioned above. The two internal follicles are those of the incisor teeth, and the external those of the molar teeth ; the fifth intermediate is that of the canine tooth.

Ossification begins at the fifth month in the inner incisor teeth, a little sooner in the lower than in the upper. Next comes the external incisor tooth, then the anterior molar tooth. About the end of the fifth month we find osseous substance in these three teeth, while only the germ exists in the other two. We have as yet been unable to determine whether the canine or the posterior molar tooth is ossified first, because, except in one instance, we have always found these teeth with or without traces of the osseous germ at the same time. Probably, however, ossification commences first in the former, not only because we have once found in it an osseous germ, while there was none in the posterior molar tooth, but because its osseous nucleus has always seemed to us more extensive than that of the latter, and finally because it is cut first. But these three reasons, particularly the last two, do not establish our opinion with certainty.

At the seventh month of pregnancy all the deciduous teeth contain osseous nuclei.(1)

The number and arrangement of the pieces of bone which form the teeth are not always exactly the same.

Hunter(2) and Rudolphi(3) think that the incisors are composed of three pieces, a central and two lateral pieces, which are smaller. The canine teeth arise by a single osseous germ according to Hunter ; but Rudolphi thinks by two lateral halves. Both admit that the anterior molar tooth is formed of an anterior portion and of one or two posterior pieces, and that the posterior is formed by an anterior germ and several posterior nuclei. Hunter however is very brief on this subject, although he seems to speak from observation. Rudolphi's assertions are grounded, not on researches in regard to the development of the teeth in the fetus, but upon chemical experiments, having for their object the action of the acids on perfect teeth, which action reduces them to the number of pieces mentioned by this physiologist. Numerous observations on the fetus have convinced us that the canine and the incisor teeth are developed by a single germ, which arises at the centre and gradually extends to the sides. We cannot then consider as natural, conclusions drawn from the action of acids on perfect teeth; and farther, because other writers, as Albinus,(4) and Blake,(5) formally assert that the incisor and the canine teeth are developed by one nucleus of ossification. But the molar teeth in fact arise by several

(1) Blake (*Essai*, p. 23) states only that he has found osseous substance in all the teeth in a fetus of eight months.
(2) *Loc. cit.*, p. 88.
(3) *Ueber die Zähne ;* in his *Anatomisch-physiologische Untersuchungen*, p. 126.
(4) *De dentium ortu et incremento ;* in the *Annot. acad.*, book ii., ch. ii., p. 16.
(5) *Loc. cit.*, p. 6.

osseous nuclei, each of which corresponds perfectly to the first rudiment of a single incisor or canine tooth.

First the anterior piece, which is the largest, appears; this corresponds peculiarly to the incisors, and is narrower according to its height than it is afterwards. Next is seen the posterior piece, which is much smaller; it igradually extends and unites to the other directly or on one of the two sides by a third which is developed at a later period. The second molar tooth arises by several pieces, at least three and generally four in number, an anterior, two lateral, and a posterior. The anterior piece is always larger than the others.

All the pieces except the small one, which belongs to the posterior molar tooth, are usually fused at birth.

About this period the development of the first and second incisor tooth is nearly equally advanced in regard to the whole crown. Next comes the anterior molar tooth, the crown of which has not yet however acquired all its height. The third is the canine tooth. The most imperfect is the posterior molar tooth, the very thin crown of which presents in one or more points considerable spaces in its central portion, and a piece which is entirely distinct from the others. The posterior molar teeth of the lower jaw not unfrequently form a single piece in the full grown fetus. Beside the spaces and the separation mentioned disappear in the two jaws in the first few months after birth.

The cutting of the deciduous teeth usually commences at the beginning of the seventh month after birth. The lower internal incisors are generally first seen; some weeks after, the upper internal incisors are cut; one or two months afterward, the upper and lower external incisors; at the end of the first year, the lower anterior molar teeth; some time afterward, the upper anterior molar teeth; at the age of eighteen months the inferior, and soon after the superior canine teeth; toward the end of the second year, the posterior molar teeth: so that at the age of three years all the deciduous teeth are seen.

The deciduous teeth receive a distinct artery, which comes from the dental artery, and which passes through a canal in the jaw, into which it enters through a special foramen.(1)

2. Permanent teeth.

§ 2123. The permanent teeth are developed and appear nearly in the same order as the deciduous teeth. They however pass through their periods much more slowly.

We observe first just before the end of the first month of pregnancy the follicle of the anterior molar tooth. Those of the incisors do not

(1) Serres, *loc. cit.*, p. 16.

form till the commencement of the eighth month; next that of the canine, and next that of the middle great molar tooth. That of the anterior small molar tooth forms some months after birth, rarely before the seventh or eighth. Next appears that of the posterior small molar tooth, and usually at four years of age that of the third great molar tooth, which is situated the most posteriorly. The osseous germs are visible nearly at the same time as the follicles.

Ossification commences in the anterior great molar tooth. Usually the external anterior point of this tooth presents at the end of the last month, of pregnancy, a small osseous piece, to which four or five others are gradually attached separately; these do not unite till the end of the first year. We however have sometimes found in a very large full grown fetus five points, in fact entirely distinct from each other, the posterior of which was still very small.

All the permanent teeth have not the same situation in respect to the deciduous teeth. The three posterior molar teeth are situated on the same range as these latter, but farther outward, while those which should be properly called the replacing teeth are included between them and the posterior wall of the alveolar processes, the incisors, the canine and the molar teeth, behind those to which they correspond. The follicles of the permanent teeth are at first contained in the same alveolar processes as the old teeth. The manner in which they are developed is very curious. They leave the upper and posterior part of the dental follicles already existing, so that they may be considered to a certain extent as arising from these latter by gemmation. They first rest directly on them, and even afterwards when they are elongated they communicate with them by long and thin cords.

Our observations, however, have established that this communication is only between the external layers of the dental follicles, that the internal layers are much more essential, and entirely distinct from each other, so that the new internal dental sac is developed in the old, between it and the external layer, although their cavities are unconnected. If they communicate, it must have been at a very remote period, since we have never been able to discover it even on examining the follicles of the permanent teeth when they first appear.

The new sacs are gradually separated from the old by the formation of new alveolar cavities. These cavities seem at first slight depressions in the posterior wall of the old; these depressions, like the follicles, are much shorter than these latter, and extend much farther beyond the alveolar edge than those which existed previously. A septum gradually arises from the base of the alveolar processes, and goes towards its orifice. The two alveolar processes, however, continue to communicate by a considerable opening, through which passes the cord which unites the two sacs. The elongation and the thinness of this cord depend on the increase in the height of the jaws.

The openings between the incisors and the canine teeth are visible on the posterior face of the jaws. That of the internal incisor tooth corresponds to the cavity of the deciduous internal incisor tooth. That

of the external is situated between the cavity of the deciduous external incisor tooth and that of the deciduous canine tooth. That of the canine tooth is situated behind the cavity of the deciduous canine tooth. The communications of the anterior molar teeth with the cavities of the deciduous molar teeth, are not visible externally, according to several anatomists,(1) but exist at the bottom of those latter; we, however, have observed that they are situated like the first, on the inside, and behind the alveolar opening of the deciduous tooth, and that they are generally narrower than the others.(2) The follicles of the second and third permanent molar teeth emerge in the same manner, the first on the outside of the deciduous molar tooth, the other afterward, on the outside of the second. The foramina of communication between their cavities are situated at the upper part of the septum which separates them. As the jaw and the deciduous teeth gradually arise by the development and completion of their roots, as the permanent teeth which replace the latter do not increase proportionally in this direction, and as they are much broader than the deciduous teeth, it follows that they are situated lower, and also a little on the outside of them. The permanent internal incisor teeth are situated behind the internal and a part of the external deciduous teeth; the permanent external teeth behind these latter and the deciduous canine teeth; finally, the anterior molar teeth behind the deciduous molar teeth and between their roots. The crowns of the latter nearly touch the roots of the permanent internal incisor teeth, and the canine teeth are on the outside of the row, more remote from the alveolar edge, and are carried farther forward than the others.

§ 2124. At the age of six or seven years the second dentition commences; the deciduous teeth fall out and the permanent teeth appear. At this time the artery of the deciduous teeth and its canal disappear more or less perfectly,(3) so that the dental capsules receive no more nutritious fluid. Usually, and in fact almost always, the permanent anterior molar teeth begin to appear before the time of the second dentition, which has deceived some writers, and led them to admit twenty-four deciduous teeth. Among the teeth which alone deserve to be called permanent teeth, the inferior internal incisor teeth usually appear first. Next come the superior internal, then the external; afterward, and usually at the age of from thirteen to fourteen years, and almost always at the same time, the canine and the middle great molar teeth appear; finally, at a variable period, between sixteen and twenty years, and sometimes later, the last great molar teeth appear, which are hence called the *wisdom* teeth (*dentes sapientiæ*). Thus, although the permanent canine teeth appear much sooner than the small molar teeth, they however normally are cut afterward, between the appearance of these latter and the posterior molar teeth, exactly as the deci-

(1) Albinus, *loc. cit.*, p. 13-15.—Blake, *loc. cit.*, p. 40.—Serres, *loc. cit.* p. 38.
(2) Meckel, *loc. cit.*
(3) Serres, *loc. cit.* p. 19.

duous canine teeth appear in the jaws between the two deciduous molar teeth.

The order then in which the teeth are cut, is nearly the same for the deciduous and the permanent teeth.

Both resemble formations which are permanent in animals.

The appearance of the incisors before the others deserves notice, as it resembles the development of the intermaxillary bone, and the corresponding middle portion of the lower jaw which exist particularly in fishes, and more or less in all animals. The earlier development of the lower represents remarkably the formation of the ruminantia, and the regular existence of the incisors and the molar teeth without the canine teeth in the rodentia.

The deciduous teeth change in certain respects before falling out. Their roots disappear; they become both shorter and thinner, so that their inner part diminishes as they terminate more or less in a point.

The more or less narrow canal in which the cavity of the permanent tooth is first situated, gradually enlarges, as well as its orifice, as the tooth advances; finally, the septum which seperates the alveolar process of the permanent tooth from that of the deciduous tooth, is destroyed, and the two teeth are then situated in the same cavity as they were originally, with this difference, however, that the permanent tooth, from its greater size, always penetrates partly into the alveolar process of the adjaeent deeiduous tooth.

The destruction of the root of the deciduous tooth doubtless depends on the mechanieal action of the permanent tooth upon it, in accordance with the law, that long continued pressure on a part, causes it to disappear by obstructing nutrition, or by accelerating the destructive process. This is proved not only by the disappearance of the deciduous tooth, but also by the well known fact that those temporary teeth which are not replaced by the permanent teeth, continue very long even in the adult, and sometimes even during existence.(1) Although the tooth which continues longer than usual often finally falls out,(2) we must not conclude that the permanent teeth have no effect in the normal state independent of their influence, but only that the deciduous teeth from their primitive destination, exist so short a time that this action is not absolutely necessary to determine their decay. Finally, the continuanee of the deeiduous teeth even after their vessels and nerves have completely disappeared, is favored by the adhesions between their root and the inner face of the alveolar process.(3)

The permanent tooth causes the decay of the deeiduous tooth principally by pressing upon the vessels and nerves of this latter, and likewise its adhesions with the alveolar process, and destroying them. The destruction of the root is not indispensible, nor even constant, as the deciduous teeth are sometimes shed, preserving their roots entire.(4)

(1) Hunter, *loc. cit.*, p. 99.—Hudson, in Blake, p. 67.—Fox, *loc. cit.*, p. 40.
(2) Fox, *loc. cit.*
(3) Serres, *loc. cit.*, p. 97.
(4) Idem, *loc. cit.*, p. 102.

This is the proximate cause of the loss of the tooth, and not, as has been asserted, the space formed by the disappearance of the septum between the alveolar processes, the only effect of which space would be to fix the tooth less firmly.(1) In fact, there is no space, since the permanent tooth, in proportion as it destroys the septum, prevents the space from forming, as it enters the alveolar process of the deciduous tooth.

§ 2125. From our preceding remarks it follows, that the teeth resemble the bones generally in their chemical composition and hardness. They however differ from them in these two respects:

1st. They are harder.

2d. Their tissue is much more solid.

3d. They are composed of two substances.

4th. They contain a much greater proportion of earthy salts.

They differ also from the bones.

5th. They are unattached in most of their extent.

6th. In their mode of connections with the rest of the body, and in their relations with the germ of the tooth.

7th. In their mode of development.

8th. Because they do not participate in the diseases of the osseous system.

9th. They receive no vessels.

10th. They resist much more the action of chemical agents and spontaneous decomposition after death.

In all these respects, on the contrary, they are very similar to the epidermoid parts, which analogy is confirmed by comparative anatomy.(2)

(1) Serres, *loc. cit.*, p. 104.

(2) Mayer and Kathoven are the first who arranged the teeth as belonging to the horny system, which has been followed by Heusinger, but opposed by Rudolphi, but very wrongly. Bonn (*De contin. membran.*, 1763, § 16), Walther (*Physiologie*, vol. i. p. 176), and Lavagna (*loc. cit.*, p. 164), had already mentioned the analogy between the teeth and the hairs. This point of doctrine had been carefully developed by Lavagna, and afterwards by Heusinger. The reasons alledged by the latter are, 1st. The teeth in the different mammalia present imperceptible transitions, from those which are most similar to the bones, to the different parts of the horny system, particularly the nails, the horns, and the hairs. 2d. The teeth of several of the mammalia have a lamellar texture like the nails and the horns, and this texture, although very evident in all, sometimes seems effaced from the greater accumulation of the earthy salts. 3d. The development of the teeth is very similar to that of the nails and horns. 4th. Certain teeth are shed and reproduced, as are also the nails and the horns. 5th. The teeth are not nourished, they are formed entirely of one piece, and the substance which forms them is not renewed. These views are in part those of Coiter, Herissant, Cuvier, and Serres. G. F. St. Hilaire has adopted them entirely. The tooth, he says, ti produced by transudation; it is an inorganic body, anatomically speaking, a mass composed of several layers, in which there is nothing to be compared with osseous tissue. But this naturalist has extended these ideas very much by demonstrating that we must refer the beak of birds to the formation of the teeth, a curious fact, and one of the highest importance, which fully justifies the analogy established between this formation and the epidermoid tissue. He advances also another idea, which we shall mention here briefly, although connected with important physiological considerations, it is foreign to this work, viz. that if the teeth afterwards serve for mastication, it is fortunate for those animals who possess and

B. ABNORMAL STATE.

§ 2126. The teeth not unfrequently vary from the normal state; and most generally present anomalies in their texture. The most frequent alterations of texture are those which relate to the period of development and the order in which it occurs; next, those which relate to the number of the teeth. Next come the anomalies in situation and direction, and finally those in form, size, and continuity of tissue.

a. Deviations of formation.

§ 2127. 1st. *Anomalies in the development.* These are the slightest. Not unfrequently all the teeth, or some of them only, appear unusually late. This is seen particularly in the last molar teeth, in regard to which we should remark, that their unusually late appearance is only an extension of time between their appearance and that of the other teeth, as between the appearance of these latter compared together. It is less common for all or some of the teeth to appear sooner than usual; sometimes, however, children are born with several teeth. It is curious, although the fact agrees very well with the laws and the other phenomena of vegetative life, that this early development seems evidently to be favored by the longer continuance of the fetus in the uterus, since in a proportionally great number of children who had continued in the fetal state some weeks beyond the common period, teeth existed at birth.

We must mention among the anomalies in the development, the continuance of the deciduous teeth beyond the usual period, which does not necessarily oppose the appearance of the permanent teeth, and causes so much irregularity in their arrangement and situation, that we are led at first view to believe the number of the teeth to be increased. But the deciduous teeth frequently remain, although the permanent teeth do not appear, and this anomaly must even be attributed to the absence of these latter.

Beside these differences in the development which relate to the quantity, there are others dependent on the quality. Thus, sometimes all the lower incisor teeth appear before one of the upper is seen. It is much more rare that the superior incisors appear before the inferior, the external before the internal, the anterior molar teeth before the external incisors, and the posterior before the canine teeth.(1) The rarest case is where the canine teeth appear before the anterior molar teeth,

profit by them, but that when the formations of the teeth begin to appear in the fetus, they are real organs of the fetus; in this sense they arise, like all the organs of sense to form a termination to the circulatory system of the advanced parts of the head, to limit a certain number of vascular trunks. F. T.

(1) Blake, p. 25.—Fox, *loc. cit.*, p. 7.—Serres, p. 85.

although several authors mention this as the normal order, or at least state it to be as frequent as that mentioned above.(1)

2d. *Anomalies in the number.* These teeth which most frequently appear later than the common period, the posterior molar teeth, are also those which are most commonly deficient. Instances, however, are known of the deficiency of every tooth.(2) In one subject there were only four permanent teeth in each jaw. In another there was only one incisor in the upper jaw. Sometimes the teeth have been entirely deficient.(3)

It is more rare to find an excess than a deficiency of teeth. This anomaly, leaving out of view that which is only apparent, and which we have just mentioned, appears principally under two different forms. Sometimes the supernumerary teeth exist simultaneously with the others; sometimes, however, they appear after them.

In the first case they make part of the same range with the others; sometimes are found out of this range, so that when several exist they form a second series. They are generally situated behind the normal teeth, that is, the same relation exists between them and these latter as between the deciduous and the permanent teeth. This anomaly varies in the same manner as that which depends on the abnormal situation of the teeth in general.

The first degree of the redundancy of the teeth is the development of one or more rounded eminences on the sides of the crown; hence are formed what are termed the *dentes proliferi.*(4) This anomaly seems to belong almost exclusively to the molar teeth, and it is curious as it is a greater development of one of their peculiar characters, the existence of several points on their crown.

The anomaly is still greater when other smaller separate teeth exist on a normal tooth, and which are seemingly formed by special germs. In the only case of this anomaly known to us, and which existed on a canine tooth, there were three accessory teeth; these small teeth were much smaller than the normal canine teeth, but were all formed after the same type; they rested on the base of the crown and had the same direction.(5)

The supernumerary teeth are observed most frequently in the upper jaw and forward, near the canine teeth and the incisors. This peculiarity is very remarkable, since in several animals the anterior teeth are more numerous in the upper than in the lower jaw. They usually

(1) Miel, *Bull. de la soc. méd. d'émul.*, 1817, p. 94.

(2) Fox mentions several instances of this.

(3) Fox. *loc. cit.*,—Sabatier, *Anat.*, vol. i. p. 78.

(4) Bartholin, *Hist. anat. rar.*, ch. i., p. 49.—Serres, *loc. cit.*, p. 160.—Linden, *Medic. phys.*, cap. xiii., art. 3.—Oudet, *Bull. de la fac. de méd.*, 1821, no. i., p. 369. —G. Saint Hilaire has described and figured one of these teeth (*Syst. dentaire des mammif. et des oiseaux*, p. 77, pl. i., fig. 18).

(5) Lemaire, *Deux observations d'anatomie pathologique sur les dents;* in the *Journ. de méd.*, vol. xxxvi., p. 252.

differ from all the normal teeth in form and size, being smaller and conical, sometimes bicuspid. When they occur at the posterior part of the mouth they do not resemble the wisdom teeth. Their number varies. Generally they are few, but sometimes they are many; in one case even the whole number of teeth was seventy-two, viz. eight incisors, four canine and twenty-four molar teeth in each jaw.(1) Possibly, however, this statement is not perfectly correct, and should be considered only as an instance of the coexistence of the deciduous and permanent teeth. Sometimes also when the number of teeth is unusually large, this anomaly is caused by the division of one or more into several.

The second mode in which the number of teeth is increased has been termed the *third dentition.* There is even sometimes a fourth dentition, although the instances mentioned of this are hardly credible. The principal circumstances of this remarkable phenomenon are as follow:

a. The third dentition is attended with the same symptoms as those of the first and second. The new teeth are smaller than those they replace; they are less permanent and soon decay.

b. The period of their formation is not determined. If we may judge of them from some facts, they are formed before they appear; probably, however, individuals differ in this respect.

c. The third dentition usually occurs at a very advanced period of life.

d. The time between the third and second dentition varies. Generally, however, the third teeth appear shortly after the second decay.

e. In this respect there are differences, some of which depend on the quantity, others on the quality. Usually however one or more teeth are replaced more frequently than all. The posterior molar teeth seem to be those which are renewed most frequently, and even if this be not true it is a fact that when they are replaced by others the same phenomena are presented as at the second dentition.

3d. *Anomalies in situation and direction.* They differ considerably:

a. Situation. In this respect the teeth are rarely abnormal, and if they are situated in the range they change their place, so that this anomaly belongs to the history of the lateral inversion. Thus the canine tooth sometimes exists between the two incisors. In other cases the canine tooth is replaced by the first anterior molar tooth, and exists between it and the second.(2) Sometimes also the teeth are developed in parts of the jaws where they are not generally found. These abnormal teeth are seen most frequently in the palatine process

(1) Arnold, *Obs. phys. med.*, p. 69.
(2) Miel, *Observation sur un cas très rare de transposition des dents*; in the *Journ. de méd.*, vol. xl., 1817, p. 88.

of the upper maxillary bone, directly or at some distance behind the normal teeth. They are in the lower jaw principally situated in its angle. The narrowness of the jaw causes them to project above the others, and their direction is also less perpendicular.

b. Direction. Not unfrequently the teeth are oblique, which depends particularly on the narrowness of the jaw; but here their faces look to the sides, and their edges are turned backward and forward. They are rarely on the contrary reversed, that is, the summits of their roots look to the alveolar edge and the crowns to the opposite region of the jaw.

4th. *Anomalies in the form.* The form of the teeth is abnormal in a great many different modes.

a. In regard to the *whole tooth*, this abnormal formation is indicated by the adhesion of two adjacent teeth; this sometimes extends their whole distance, and is sometimes confined to a portion of their extent, generally to the roots.(1)

b. Crown. The form of the triturating surface of the crown sometimes varies very much from the common form.

The first great molar tooth seems particularly to have a peculiar tendency to the imperfect development of this surface; for we have sometimes found it on each side in both jaws with a great number of small eminences, a curious analogy with the molar teeth of the hog.

The rest of the crown, instead of being smooth as usual, sometimes presents rounded, transverse, and longitudinal elevations and depressions, which depend on a deficiency in the secretion of the enamel.(2)

The crown more rarely presents so irregular a form that it appears to be compressed from above downward and reversed.(3)

c. Roots. The roots are abnormal more frequently than the crowns. Their principal anomalies are an excess in number and a variation in direction.

Sometimes, although very rarely, the superior molar teeth have five roots,(4) and the inferior four.(5) More frequently these latter have three. In some subjects we find two in the canine teeth and more rarely in the incisors.(6)

In the abnormal direction of the roots of the teeth they are curved very much in the form of a hook,(7) or they are oblique. These two anomalies are most frequent, particularly in the great molar teeth, which they render more solid.

(1) Fox, *loc. cit.*, tab. viii., fig. 8–11.
(2) Idem, *loc. cit.*, tab. viii., fig. 14.
(3) Idem, *loc. cit.*, tab. viii., fig. 11, 12.
(4) Idem, *loc. cit.*, fig. 13.
(5) Idem, *loc. cit.*, fig. 11.
(6) Tesmer, *Obs. ostcol.*, vol. i., fig. 1–4.
(7) Lemaire, *loc. cit.*, p. 254.

5th. *Anomalies in size.* The upper internal incisors are principally abnormal in this respect from a primitive deviation of formation, being much larger than usual. But the size and mass of the teeth may also be increased or diminished from too great or too slight activity in the formative power.

The roots particularly increase in size, being affected with *hyperostosis.*(1) Sometimes, although more rarely, the crown is unusually large. We must also mention here the formation of a bony substance in the cavity of the tooth, which sometimes adheres to the parietes and sometimes is developed in the centre of the soft pulp which fills this cavity.(2)

Atrophia is the opposite of hyperostosis; when it takes place in the crown it sometimes does not extend beyond the enamel, or at least it begins with the layer of enamel, although it extends gradually to the osseous substance. This latter is unaltered in its texture, and the cavity of the tooth is not exposed. The anterior teeth are more subject to this disease, which attacks only their anterior face and is seen particularly in scrofulous subjects.

6th. *Solutions of continuity.* The fractures of the teeth rarely supervene unless preceded by an alteration of texture, which renders these parts brittle. In this case, whether the scale be detached or there is simply a fissure, the solution of continuity does not close, while it is perfectly healed even when there is a loss of substance, when the tooth is perfectly healthy. The latter applies equally to transverse and longitudinal fractures.

The fractures of the roots, however, alone are consolidated. Those of the crowns do not heal, which undoubtedly depends on the fact that union takes place by an exudation of osseous substance on the outer face of the germ of the tooth, in accordance with the law of the normal formation of the tooth. It appears then from this, that the external membrane, termed the periosteum of the tooth, takes no more part in the cicatrization than in the primitive formation of the tooth.(3)

b. Alterations of texture.

§ 2128. The *alterations in the texture of the teeth* are:

1st. *Caries.* It is the most common. It usually proceeds from without inward, more rarely from within outward, begins by the destruction of the enamel, and seldom extends beyond the crown. It attacks the molar teeth most frequently. It is rarely or never observed at an advanced age.

(1) Fox, *loc. cit.*, tab. i.
(2) Duval, *Cons. méd. sur les dents;* in the *Journ. de méd.*, vol. xxxvi.; *Bull. de la fac. de méd.*, p. 101.
(3) Duval, *Sur la consolidation des fractures des dents;* in the *Journ. de méd.*, vol. xiii., p. 275.

Sometimes the germ inflames, suppurates, and dies, independent of the solid substance of the tooth.(1) Its inflammation seems to precede the caries of the tooth.(2)

2d. The teeth rarely participate in the general *softening* of the bones.

3d. The formation in the alveolar processes of cysts filled with a liquid sometimes serous and sometimes thicker than serum. These cysts partially destroy the root of the tooth.

The gum frequently softens, and then bleeds at the least touch.

The abnormal swelling of this tissue with softening constitutes *epulis*, which term embraces, however, very different alterations of texture.

II. CERVICAL AND THORACIC PORTIONS OF THE ALIMENTARY CANAL.

§ 2129. The cervical and thoracic portion of the alimentary canal(3) are much more simple than the cephalic. They include the *pharynx* and the *esophagus*. The first begins at the posterior extremity of the cavities of the mouth and nose, and is uninterruptedly continuous with the esophagus, which is connected with the stomach.

A. PERFECT STATE.

1. PHARYNX.

§ 2130. The *pharynx*(4) extends in a straight line from the base of the skull and the fauces to the lower extremity of the larynx, or to the fifth cervical vertebra. Its mean measure is four inches long, and one in diameter at its broadest part when moderately distended. Below this point it contracts, then dilates again, becomes narrower, and is finally continuous with the esophagus.

Its posterior straight face is situated directly before the five superior cervical vertebræ and the anterior muscles of the neck, behind the cavity of the mouth and the larynx, between the great vascular and nervous trunks of the neck.

Its upper extremity or arch (*fornix*) is united by some cellular tissue to the lower face of the body of the basilar bone and the petrous portion of the temporal bone. Some muscles to be described hereafter

(1) Duval, *loc. cit.*, vol. xxxvi., p. 99, 100.
(2) Serres, *loc. cit.*, p. 51.
(3) Fabricius of Aquapendente, *De gulâ et ventriculo*, Padua, 1618.—J. Fantoni, *De gulâ et ventriculo*, Turin, 1742.
(4) Santorini, *De pharynge*; in the *Obs. anat.*, cap. vii.

attach it to different parts of the head. Upward and backward are the posterior nostrils, forward the orifice of the cavity of the mouth, backward and on the sides those of the Eustachian tubes. These different openings exist at its upper part, which is divided by the soft palate to a certain extent into an anterior and a posterior passage.

§ 2131. It is surrounded externally by a thin layer of cellular tissue, which attaches it loosely to the adjacent parts. Below this layer is another, which is easily separated from it; this is also cellular and is filled with fat, and intimately unites it with the subjacent muscular layer. The nervous and vascular trunks which enter into the proper membranes of the pharynx are distributed in them.

§ 2132. The muscular tunic of the pharynx is formed principally by the three *constrictor* muscles (*M. constrictores pharyngis*),(1) a *superior*, a *middle*, and an *inferior*. These muscles have several common characters, which are:

1st. They surround the pharynx backward and on the sides; their lateral extremities are attached to the adjacent hard parts before the pharynx, especially to several bones of the face and skull, to the hyoid bone and to the larynx.

2d. They are composed of fibres which proceed from below upward and from without inward, and which extend by radiation from each side to the median line.

3d. They partially cover each other from below upward.

4th. They are voluntary muscles.

A. CONSTRICTOR PHARYNGIS INFERIOR.

§ 2133. The *constrictor pharyngis inferior* or the *crico-thyreo-pharyngeus* muscle arises by from two to four triangular digitations, from the cricoid and the thyroid cartilages.

The lowest and smallest is attached below the crico-thyroideus muscle to the lower part of the side, and to the lower part of the posterior horn of the cricoid cartilage.

The upper, the larger, is sometimes single and sometimes triple; it arises from all the posterior part of the side of the thyroid cartilage, excepting the lower region occupied by the crico-thyroideus muscle, which is situated between it and the lower digitation.

The fibres of this muscle proceed from all these points, divided into several fasciculi in a greater or less extent, and go toward the median line, so that the inferior are almost transverse, while the others ascend more the higher they become, and unite at angles more and more acute with those of the opposite side on the median line.

(1) Santorini, *Septemdecim tabulæ*, tab. vi.

The upper head of this muscle is only about an inch below the upper extremity of the pharynx.

B. CONSTRICTOR PHARYNGIS MEDIUS.

§ 2134. The *constrictor pharyngis medius* muscle (*M. constrictor medius pharyngis*, s. *glosso-hyo-pharyngeus*, s. *kerato-chondro-pharyngeus*, s. *cephalo-pharyngeus*) is much smaller and weaker than the preceding. It arises from the hyoid bone and the tongue, generally by two heads. The *inferior* or *posterior*, the smaller, termed the *hyo-pharyngeus* muscle, comes from the posterior part of the upper edge of the great horn of the hyoid bone.

The *upper* or *anterior*, which is the larger and is termed the *glosso-chondro-pharyngeus* muscle, arises from the small horn of the hyoid bone and from the base of the tongue.

Its lower fibres are transverse and even convex downward; the upper are very oblique and are generally pointed, and either alone or blended with the upper fibres of the constrictor pharyngis inferior muscle, extends as the *cephalo-pharyngeus* muscle; to the basilar process of the basilar bone, and is attached to its lower face by fleshy or tendinous extremities.

C. CONSTRICTOR PHARYNGIS SUPERIOR.

§ 2135. The *constrictor pharyngis superior* or the *glosso-mylo-pterygo-pharyngeus* muscle arises from the posterior part and the side of the root of the tongue, from the inner face of the lower maxillary bone, near the posterior molar tooth, from the hook of the pterygoid process, and from the tendon of the peristaphylinus externus muscle, often also a little from the petrous portion of the temporal bone and from the styloid process, and blends with the posterior part of the genio-glossus and buccinator muscles, and often also with the lower portion of the stylo-pharyngeus muscle.

Its lower fibres are transverse; the upper describe an arch which is convex upward.

D. STYLO-PHARYNGEUS.

§ 2136. The *stylo-pharyngeus* muscle (*M. stylo-pharyngeus*, s. *levator*, s. *dilator pharyngis*) is large, elongated, and rounded. It arises by a broad and short tendon from the inner face and the lower edge of the styloid process of the temporal bone. Thence it goes inward and downward. It is at first separated from the constrictor pharyngis superior muscle by a greater or less quantity of fat; it goes from above downward and from without inward, passes under the lateral part of

the constrictor medius muscle, and is distributed on the lateral and posterior wall of the constrictor medius, and adheres to its vascular tunic very intimately by a dense cellular tissue.

Its upper fibres curve in an arch from below upward and interlace with those of the superior constrictor. The inferior separate like a pair of forceps. Both descend to the base of the upper horn of the thyroid cartilage, and are attached to its posterior edge.

This muscle raises the pharynx and the larynx, and dilates the first of these two cavities transversely.

§ 2137. The vascular tunic of the pharynx which is considerably thick comes next to the muscular portion.

The inner tunic or the mucous membrane is very thin, smooth, and reddish white. It is uninterruptedly continuous above with that of the mouth and nose, below with that of the esophagus.

II. ESOPHAGUS.

§ 2138. The *esophagus*(1) is that part of the alimentary canal included between the pharynx and the stomach. It is narrower than either, and is continuous with them at its two extremities by tunnel-like portions.

This canal is situated in the posterior mediastinum, and extends its whole length before the vertebral column. Its upper part corresponds directly to the anterior face of the spine from the fifth cervical vertebra and the cricoid cartilage, where it commences, to the fifth dorsal vertebra, although it frequently also inclines a little to the left. From this point to the ninth dorsal vertebra it inclines slightly to the right; it then returns on the anterior face of the column, passes through the esophageal fissure of the diaphragm, and soon terminates at the upper or left orifice of the stomach.

At its upper part it is situated behind the trachea. From the fifth dorsal vertebra it is found between the aorta on the left and the azygos vein on the right side. It is united to the adjacent parts by a very loose cellular tissue.

§ 2139. The esophagus is the narrowest part of the alimentary canal. Even in its greatest dilatation its diameter is not an inch. It is equally broad in every part, except at most the slightly contracted portion which passes through the diaphragm.

The muscular tunic is considerably thick; it is generally at least a line in thickness.

It is composed of two layers, one external longitudinal, the other internal transverse, the first of which is twice as thick as the second. The longitudinal fibres usually commence above by three fasciculi or

(1) J. Bleuland, *Observationes anatomico-medicæ de sana et morbosa œsophagi structura*, Leyden, 1785.—V. Malacarne, *Sull' esofago, sulle intcstine, e sopra alcune valvulo del tubo alimentare*, Padua, 1803.

heads, a middle and two lateral. The middle head arises by a tendon from the centre of the posterior face of the cricoid cartilage directly below its upper edge, and expands a little in descending. The two lateral heads, which are fleshy, descend from the lower edge of the constrictor pharyngis inferior muscle. These three fasciculi unite some inches below the upper extremity to form a muscular membrane which is uniformly extended.

The circular fibres are a continuation of the inner posterior part of the constrictor pharyngis inferior muscle, but are much thinner than those of this muscle.

The upper are transverse; the next are oblique from above downward and from without inward, intercross with those of the opposite side, and describe spiral lines; the inferior, like the superior, form straight rings. This canal for about an inch at the upper end of the esophagus presents no circular fibres on its anterior face, and as the longitudinal fasciculi are not united in this place, the esophagus is here much less muscular and more extensible than in other parts.

The cellular or vascular tunic comes next to the muscular, and is attached to it very loosely, while it adheres strongly to the internal membrane with which it forms an internal canal which is easily detached from the muscular membrane.

In this tunic there are numerous muciparous glands arranged very compactly and composed of smaller granulations, which diminish in number and size as they approach the lower extremity.

The inner or villous tunic is whitish, solid, and presents, on its inner face, numerous and very narrow longitudinal grooves separated by parietes. We ought not to consider it as the same with the preceding.(1)

Its inner face is covered with a thinner, more delicate, and moist membrane, which is evidently an epidermis, and which suddenly terminates at the lower part of the esophagus at the part where it is continuous with the stomach. The folds of this epidermis are easily separated by boiling and maceration, although it is difficult to detach it entire unless it is morbidly thicker and firmer from some pathological change. Farther the lower extremity of the esophagus is detached from above downward in one or more parts sometime after death, which undoubtedly arises from the fact that the fluid secreted by the glands of the esophagus and cardiac portion of the stomach soften and dissolve it, and also the loose cellular tissue which unites it to the cellular tunic.

(1) Sœmmerring (*Eingeweidelehre*, p. 216) describes these two tunics as forming but one, termed the *vascular* or *internal glandular tunic;* he says that the inner membrane and the vascular membrane of the stomach are continuous with it. It is true that the internal membrane of the stomach is continuous with that of the esophagus, and its vascular membrane with that of this canal. Other anatomists err still more in considering the villous tunic of the stomach and intestinal canal as a continuation of the epidermis of the esophagus.

§ 2140. After the food is masticated by the teeth in the cavity of the mouth, mixed with the saliva and formed into a soft mass, the muscles of the tongue, the hyoid bone, the pharynx, and the esophagus propel it successively toward the stomach; this constitutes *deglutition* (*deglutitio*).(1) In order to this, the mass of food is moved from before backward in the cavity of the mouth, which motion requires the close of this cavity by approximating the jaws and lips. At the same time, the tongue is moved by its muscles, so that its edges are raised and its centre is depressed, and it thus forms a kind of groove, which touching the palate makes a canal, in which the food proceeds from before backward, because there is the least resistance in this direction. When it has passed through this course, the genio-glossi and genio-hyoidei muscles, which restore the tongue to its position and carry it forward also favor its progress, because they thus raise the soft palate, to which motion also the levator muscles of this latter contribute. When the food has arrived at this place the constrictor muscles of the pharynx contract; at the same time the depressors of the soft palate and the stylo-glossi muscles act to raise the tongue and contract the isthmus of the fauces; the contractions of the constrictor pharyngis superior muscle press the pharynx against the soft palate, and thus close the nasal fossæ as they had been before by raising the soft palate. The stylo-pharyngei muscles, then the constrictors of the isthmus of the fauces, raise and dilate the pharynx, so that the food can enter there more easily.

The genio-hyoidei, the mylo-hyoidei, the thyro-hyoidei and the hyo-glossi muscles carry the larynx forward and upward; this motion favors the closing of the glottis by the epiglottis, which the pressure of the food also serves to depress, so that nothing can enter the air passages.

All these parts being extremely irritable act very rapidly and easily. Deglutition, which is at first voluntary, becomes involuntary in the esophagus, although this passage receives its nerves from the pneumogastric nerves.

B. ABNORMAL STATE.

I. DEVIATIONS OF FORMATION.

§ 2141. 1st. *Primitive deviations.* Sometimes but rarely the pharynx and the esophagus terminate in a cul-de-sac, one at its lower the other at its upper part, from a primitive deviation of formation. In the

(1) Schulze, *De deglutitionis mechanismo*, Halle, 1739.—F. B. Albinus, *De deglutitione*, Leyden, 1740.—Wentz, *De deglutitionis mechanismo*, Erlangen, 1780.—P. J. Sandifort, *Deglutitionis mechanismus, verticali sectione narium, oris, faucium illustratus*, Leyden, 1805.

first place the cavity of the mouth also is generally at least imperfectly developed, and the lower jaw is wholly or in great part deficient. The same thing occurs when the pharynx opens in the neck by a very narrow orifice.

Another primitive deviation of formation which is more rare, is the division of a part of the esophagus into two passages situated at the side of each other.(1)

We cannot always determine if the *contractions* of the esophagus, which depend on the abnormal folding of the inner membrane without any morbid change, are primitive deviations of formation, or are produced consecutively by a simple increase of this membrane.

We must however admit that this latter sometimes occurs, since accidents frequently appear only a little while before death.

2d. *Accidental deviations of formation. Dilatations* of the esophagus are generally accidental. They usually occur after contractions situated below them, and in this case they are *general.*

More unfrequently a portion of the circumference of the canal appears dilated in a cul-de-sac.(2) In one case the pouch was certainly caused by a hernia of the internal membrane through the muscular tunic,(3) while in another this latter also contributed to it.(4)

Pouches of this kind occur only at the lower extremity of the pharynx or at the commencement of the esophagus, doubtless on account of the sudden contraction of the alimentary canal in this place, and because the esophagus is less muscular there than in other parts.

Ruptures of the esophagus which are sometimes transverse(5) and sometimes longitudinal,(6) are only a greater degree of the hernia of the inner membrane. They are sometimes caused by abnormal brittleness.

When the *contractions* are permanent, they generally supervene after a morbid alteration of texture, as thickening and induration of the coats of the esophagus, so that they are rarely pure deviations of formation. Sometimes, however, they depend originally on a simple abnormal contraction of the muscular fibres, which continues even after death; and the greater hardness in this part does not result from an alteration of texture, but only from a stronger contraction of the muscular tunic, although the continual pressure of the latter on the inner membrane may also change its texture, and excite in it inflammation,

(1) Blaes, *Obs. medicæ rariores*, tab. vi., fig. 2.
(2) Meckel, *Handbuch der pathologischen Anatomie*, vol. ii.—Bell, *Surgical observations*, pt. i., London, 1817, p. 167, tab. ii.
(3) Bell, *loc. cit.*
(4) Ludlow, *Med. obs. and inq.*, vol. iii.
(5) Boerhaave, *His. morbi atrocis*, Leyden, 1724.
(6) Monro, *Morbid anatomy*, p. 311.

followed by effusion and suppuration, which render the induration permanent.(1)

II. ALTERATIONS OF TEXTURE.

§ 2142. The most common alteration in the texture of the esophagus, is an abnormal hardness, usually attended with thickening, and consequently with a greater or less contraction, or even with a total closing of it,(2) which state is termed a *scirrhus*, and in which the different tunics of the passage are more or less blended in a mass, sometimes homogeneous and cartilaginous, sometimes divided into several compartments by tendinous septa. Commonly then the texture of the inner face is altered. This alteration is not observed in all parts indiscriminately; it is more frequent at the upper and lower extremities of the esophagus, in the former place, on account of the sudden contraction of the pharynx ; in the latter, because the lower portion of the esophagus tends to contract, since the two orifices of the stomach are perfectly closed during digestion, so that it is very easily injured by substances passing through it.

Abnormal communications between the esophagus and the adjacent parts, particularly the trachea,(3) the lungs,(4) the aorta,(5) may occur from cancer or common ulcerations. This state may also be occasioned by ulcers formed primitively in the aorta.(6)

We can sometimes, but not always, determine from the state of the parts, which was the primitive disease.

Beside the alterations of texture in the membranes mentioned, *excrescences*, *funguses*, and *polypi* of different kinds, are sometimes, although rarely, developed in the pharynx and the esophagus ; these arise from the inner face of this canal,(7) and usually have their roots in the mucous and vascular membranes. They are sometimes so long, that commencing near the upper extremity of the esophagus, they descend to the stomach. They are sometimes formed by fibres perpendicular to their base,(8) are sometimes lobed(9) and suppurate.(10)

Real ossifications are still more rare.(11)

(1) Baillie relates several instances of it: we also have seen it, and like Baillie in the cadavers of females. Mauchart, *De struma œsophagi ejusque coalitu*, Tubingen, 1742.

(2) Gyser, *De callosa œsophagi angustia*, Strasburg, 1770.—J. Bleuland, *De difficili aut impeditu alimentorum depulsione*, Leyden, 1780.

(3) Van Dœveren, *Obs. anat. pathol.* Leyden, 1789, obs. ii.

(4) Bleuland, *loc. cit.*, obs. i. p. 48. fig. 112.

(5) Van Dœveren, *loc. cit.*, obs. i.

(6) We have one very remarkable case before us.

(7) Monro, *loc. cit.*, p. 184-189.—Baillie.

(8) Baillie, *loc. cit.*

(9) Monro, *loc. cit.*, p. 188.

(10) Baillie, *loc. cit.*

(11) Meckel, *Handbuch der pathologischen Anatomie*, vol. ii. p. 2. p. 227.

ARTICLE SECOND.

MIDDLE AND INFERIOR PORTION OF THE ALIMENTARY CANAL.

§ 2143. The middle region of the digestive system comprehends the *stomach* and the *small intestine*, and the most important glandular organs of this system, the *liver*, the *spleen*, and the *pancreas*. This is the largest and the most important portion, because digestion takes place in it, for which the preceding portion only prepares, while the terminating portion serves for the expulsion of the residue.

The stomach, the liver, the spleen, and the pancreas, with the commencement of the small intestine, the *duodenum*, into which the pancreas, the liver, and the stomach open, occupy the upper part of the abdominal cavity. They are separated from the lower, which is larger, by a large transverse fold of the peritoneum, the transverse meso-colon. It is not, however, necessary to describe the lower portion of the intestine after these glands, nor to separate the large intestine from the small, since they are both situated in the same cavity, their texture is essentially the same, and they are uninterruptedly continuous with each other.

It is customary to describe the *peritoneum* before mentioning the parts of the digestive system it envelops; but as these are not the only parts covered by it, the prolongations which extend from its outer sac to the organs covered by it, cannot be clearly described until the situation and form of these organs are well known: finally, the important anomalies of this membrane, especially those which occur in hernias, being dependent on those, to which several of the parts it envelops are subject, it is better to defer the description of the peritoneum until we mention the different systems it supports. This is the method followed by Roux in the *Anatomie descriptive* of Bichat.

We shall not describe on this occasion the cavity of the abdomen, the most general characters of which have been already mentioned.

A. PERFECT STATE.

§ 2144. The different regions of the middle portion of the alimentary canal, doubtless differ very much in respect to their capacity; but they are very analogous in regard to texture, in which, however, they differ on the contrary, from the upper and lower portions. The longitudinal fibres of the muscular tunic completely surround this portion of the canal; the vessels which go to it are more numerous, and anastomose together more frequently, and finally, the inner surface of the membrane is more or less uneven, from prominences which do not exist in the other two portions.

I. STOMACH.

§ 2145. The *stomach* (*ventriculus, stomachus*),(1) the broadest part of the alimentary canal, is included between the esophagus and the duodenum. The portion of this canal in the cavity of the abdomen commences with it. The alimentary substances all fall directly within it, assimilation there commences, and they are there changed into a liquid of a peculiar character called *chyme* (*chymus*).

A. SITUATION.

§ 2146. The stomach is situated at the upper part of the abdominal cavity, under the left false ribs. Sometimes, when it is much larger, it descends into the umbilical region. Its direction is oblique from above downward and from left to right. Its upper extremity touches the diaphragm; the lower extends to near the lower edge of the left or square lobe of the liver.

§ 2147. The spleen is situated near its left extremity; behind its posterior face is the pancreas, below it the transverse colon, above it the left or square lobe of the liver and the lobe of Spigel, which is embraced by its upper curve.

B. FORM.

§ 2148. The stomach has the form of an elongated cone, a little curved on itself, and is somewhat similar to a bagpipe. Its right extremity is the narrowest, and its left the broadest portion.

We distinguish in it two orifices, two curves, and two culs-de-sac.

The *upper* or *left* orifice, termed also the *cardiac* (*ostium ventriculi sinistrum*, s. *superius*, s. *cardia*), occupies the highest part of the stomach near its left cul-de-sac. It serves as the limit between this viscus and the esophagus, which, however, are continuous with each other and separated by no prominence, so that the lower extremity of the esophagus gradually enlarges.

The *inferior* or *right* orifice, termed also the *pylorus* (*ostium ventriculi dextrum*, s. *inferius*, s. *pylorus*, s. *janitor*,)(2) is the limit between the stomach and the duodenum. Here the transition is not gradual and imperceptible as on the left side, but occurs by a prominence termed the *valve of the pylorus* (*valvula pylori*).

The faces and the curves of the stomach are included between these two orifices.

(1) Beside the works of Fabricius, of Aquapendente, Glisson, and Fantoni, already cited, consult also J. D. Metzger, *Ventriculus humanus anatomice et physiologice consideratus*, Konigsberg, 1788.

(2) Leveling, *Pylorus anatomice atque physiologice consideratus*, Strasburg, 1764.

The *posterior* and the *anterior* faces, when the stomach is more or less distended, are uniformly convex, but when the stomach is empty they are straight, flat, and in contact.

The *upper* or *small curve*, the *diaphragmatic edge*, is situated between the right side of the upper, and the left side of the lower orifice; it is concave and much smaller than the lower, which is also called the *great curve*, the *colic edge*.

When the stomach is empty, the two curves appear as more or less distinct edges, which establish a well marked separation between the two faces. But when the viscus is full, they are very rounded, and insensibly continuous with the two faces.

The *base*, *tubercle*, or *great cul-de-sac* of the *stomach*, the *splenic extremity* (*fundus*, s. *saccus cœcus*), is a prolongation in the form of a cul-de-sac which extends from right to left on leaving the left side of the upper orifice, and which proceeds about three inches beyond the insertion of the esophagus.

This portion of the stomach is not much narrower than its centre. On leaving it and the cardiac orifice, the viscus slightly enlarges to a little beyond its centre from left to right. From this latter point to the pylorus, it gradually contracts very much.

When one or two inches from the pylorus, the great curve suddenly inclines inward, but immediately resumes its former direction, although it does not afterward describe so great a curve as in the rest of its course. Hence, there is a fissure, opposite which the right portion of the small curve, instead of preserving the concave form which it possessed from the cardiac orifice, becomes convex outward, although in this place there is no contraction, between which and the pylorus is a dilatation.

The portion of the stomach farthest from the right side, is termed the *antrum of the pylorus*, or the *small cul-de-sac* (*antrum pylori*).

c. DIMENSIONS.

§ 2149. The size of the stomach varies much in the same individuals, in the state of health at different periods; as this viscus dilates considerably when filled with food, and contracts when empty. Its capacity is diminished particularly in the transverse direction, and often to such an extent that the stomach is smaller than the large intestine is when in its usual and moderate state of distention.

Generally, when the stomach is not unusually full, it is one foot long from the base to the pylorus, three or four inches high in it highest part, and about as many broad from before backward. Its surface is about one square foot in extent.

d. ATTACHMENTS.

§ 2150. The stomach is attached on each side at its upper orifice by a short fold of peritoneum, termed the *phreno-gastric* ligament (*L.*

phrenico-gastricum), which extends on the left to the commencement of the base, and descends on the right along most of the small curve. This ligament is attached forward and upward to the superior lumbar portion of the diaphragm.

To this ligament is attached another which is much longer, the *gastro-splenic* ligament (*L. gastro-splenicum*), which extends from the base of the stomach to the fissure of the spleen, where it is attached, and which is continuous below with the great epiploon.

The stomach is united to the transverse colon by the great epiploon, and to the liver by the small epiploon, internal prolongations of the peritoneum, which we shall describe after giving the history of this membrane.

E. MEMBRANES.

§ 2151. The stomach is enveloped by the peritoneum in every part, excepting a narrow ring which exists along the great and small curve, and along which the blood-vessels proceed.

Below this peritoneal coat, directly on its inner face, is the muscular membrane,(1) which is very strong, but stronger than in the great and the small intestine, although weaker than in the pharynx and rectum. It is about half a line thick, and its texture is more complex than in the rest of the alimentary canal, and we may, at least in some parts, demonstrate three layers.

The external layer is formed of longitudinal fibres, which mostly blend with those of the esophagus and duodenum, and are uninterruptedly continuous with them. These fibres are very much developed at the upper part of the stomach, around its small curve; they however cover all its surface.

The middle layer is formed by annular fibres, representing rings, the centre of which correspond to the longitudinal axis of the stomach. They commence at the base of the stomach, and interlace with each other, proceed a little obliquely, and cover the whole stomach to the pylorus, where they are strongest.

They are termed transverse or oblique fibres. They form the thickest layer.

Below this layer there is a third,(2) which is very evident on the left side, and on the small curve, and which also surrounds the stomach circularly, but in an opposite direction from the preceding, that is, longitudinally. They are the continuation of the circular fibres of the esophagus, and frequently interlace with the oblique fibres.

The vascular membrane of the stomach is thicker, more vascular, and more distinct from the internal membrane than in the esophagus.

(1) D. G. Galeati, *De cornea ventriculi et intestinorum tunica*; in *Comm. Bonon.*, 1745.—Bertin, *Description des plans musuleux dont la tunique charnue de l'estomac humain est composée*, vol. ii. p. 235.

(2) Galeati (*loc. cit.*, p.240) described this membrane long before Bertin.

It is uninterruptedly continuous with the vascular tunic of this canal, but not with the inner or villous membrane.

The villous membrane of the stomach is thin, soft, loose, and spungy, softer and looser, but a little thicker than the corresponding membrane of the esophagus. It usually assumes, soon after death, a yellowish, brownish, or reddish tint.(1) Not unfrequently, especially when examined shortly after death, it presents in a greater or less extent, especially at the base and at the small curve, a very red color, caused by a network of small vessels almost exclusively veins. We generally consider this state as the consequence of an inflammation which had affected the organ during life; and conclude from its existence that the patient had been poisoned. But attentive examination demonstrates that it supervenes during the struggles of death, without any suspicions of such a cause, and is occasioned particularly by the sudden suspension of the circulation in the lungs.(2)

When the stomach is not distended, its villous membrane, and consequently its inner face, present numerous large and small wrinkles, which are arranged very irregularly. But these wrinkles disappear when this viscus is even very moderately distended, so that when we look at the membrane with the naked eye its inner face seems smooth, although when examined with a microscope this same face seems divided by several small intermediate parietes; which enlarge toward the pylorus and by this are still more similar to the villosities of the intestines, into numerous compartments; these are arranged very compactly, like the cells in a bee-hive.(3) The cellules are larger but fewer in the left half of the stomach, and are separated by simple septa. In the region of the pylorus, these septa present numerous grooves which render them still more similar to the villosities of the intestines, although they are much smaller in other respects than these latter.(4)

Beside numerous slight depressions, which are the orifices of small simple glands, the inner membrane of the stomach also presents, espe-

(1) The French physicians having studied for several years the alterations in the mucous membrane of the digestive canal, they have naturally considered also its normal conditions. Rousseau (*Des différens aspects que présente, dans l'état sain, la membrane muqueuse gastro-intestinale;* in the *Archiv. génér. de méd.*, vol. vi. p. 321) has observed, that in the healthy state *it is white or slightly rosy white.* This primitive color varies in different parts of the alimentary canal. Thus, the mucous membrane of the pharynx is slightly rosy; that of the esophagus is white, particularly at its lower part; in the stomach it has a slight rosy tint as in the pharynx. This rosy color becomes less intense in its pyloric portion, changes to white in the duodenum, preserves this appearance in the rest of the small intestine, then becomes of a pale white in the cœcum, the colon, the commencement of the rectum, and resumes its slightly reddish color near the end of this last intestine. F. T.

(2) J. Yelloly, *On the vascular appearance of the human stomach, which is frequently mistaken for inflammation of that organ;* in the *Med. chir. trans.*, vol. iv. 1813, p. 371–424.

(3) Hewson, *Experim. inq.*, vol. ii., p. 173.

(4) E. Home has figured this (*Observations on the gastric glands of the human stomach and the contraction which takes place in that viscus;* in the *Phil. trans.*, 1817, pt. i., p. 347, pl. i, xviii, xix.

cially near the two orifices, others which are larger and which lead to more or less apparent large glands. These last glands form at the union of the esophagus and stomach a very marked prominence from three to four lines broad, which separates the two cavities to a certain extent.

The villous membrane of the stomach is uninterruptedly continuous with that of the esophagus and intestinal canal. But it does not seem to be connected with the epidermis of the esophagus, since we may without the least violence separate this epidermis from it and from the villous tunic of the esophagus around the cardiac orifice.

The membranes of the stomach vary in thickness in different individuals, and in different parts of this viscus of the same individual, and at different periods.(1)

Generally, in the first respect, they are thickest in those male subjects who enjoy good health, and in the second they are thicker, as is easily imagined, the less the stomach is distended. In regard to the third we may admit that the peritoneal coat is equally thick in every part, while the others are much thinner in this cul-de-sac of the stomach than in the other parts of the viscus, and are thickest near the pylorus, where they are frequently six times thicker than at the base.

F. VALVE OF THE PYLORUS.

§ 2152. The *valve of the pylorus* (*valvula pylori*) is formed by the circular fibres of the muscular tunic, and also by the vascular and mucous tunics of the stomach and duodenum. The first two membranes are much thicker in this place, and all three are reflected on themselves from without inward.

The longitudinal fibres in the peritoneal coat only pass on this point to the outside.

It is very easy to remove the valve by cutting or raising the longitudinal fibres. But there is always a contraction at the union of the stomach with the duodenum.

A peculiar glandular substance has been mentioned as situated between the muscular and peritoneal tunics, and as forming the pylorus and determining its form;(2) but with the utmost care in our dissections we have never been able to discover the least trace of this substance, although we always find a very thick glandular layer before the pylorus, below the muscular membrane of the duodenum.

The form of the valve varies.

It generally circumscribes the whole orifice of the viscus, and it is sometimes circular and sometimes more or less oval; in the latter case its longitudinal diameter usually extends from above downward.

(1) Velloly, *loc. cit.*, p. 400, 402.
(2) Sœmmerring, *Eingeweidelehre*, p. 236.—Portal, *An. méd.* vol. v., p. 161.

It is more unfrequently semicircular, surrounding only a part of the orifice.

Between this formation and the preceding there is an intermediate degree in which the valve differs considerably in its breadth, according to the different parts in which it is examined.

It is sometimes larger and sometimes smaller.

It is not certain that we ought always to admit that it possesses during life the form which it has after death.

We cannot determine precisely what effect a given form of the valve has even, admitting its existence and permanence during life, on the action of the valve and on the more or less closing of the pylorus by it, since it is evident that the degree of contractility in the circular fibres which contribute principally to form this fold has still more influence.

G. TRANSIENT MODIFICATIONS IN THE FORM AND SITUATION OF THE STOMACH.

§ 2153. The stomach presents regularly transient modifications in its situation, according as it does or does not contain food. These modifications correspond then to the different states of digestion.

The stomach is not only smaller when perfectly empty than when it contains food, but then its form is not cylindrical. Its anterior and posterior faces touch and its two edges are distinct from each other, while when full, its edges and faces are imperceptibly continuous.

A still more remarkable modification occurring during digestion, is, that the stomach is then divided into a right and a left half; this occurs about its centre, and is more or less distinct. The left half contains the fluids and the right the solid substances, and the former pass out from them into the small intestine without proceeding necessarily or at least entirely through the right half and the pylorus.(1)

The orifices of the stomach are more or less perfectly closed during digestion; when, however, this process has continued some time the pylorus opens, and the mass contained in the stomach passes through it to descend into the duodenum, in proportion as it is digested.

The situation of the stomach also changes during digestion; it turns on its axis, so that its anterior face looks more upward and the posterior downward, although this apparent change in situation depends principally on that in its form above mentioned.

H. FUNCTION OF THE STOMACH.

§ 2154. The inner membrane of the stomach secretes the *gastric juice* (*succus gastricus*), a fluid the exact nature of which it is difficult to determine, as it is always more or less mixed with the substances

(1) E. Home, *Lectures on comparative anatomy*, vol. i., p. 138.

introduced into this viscus. It generally contains an uncombined acid.(1)

It however appears to be sometimes acid and sometimes neutral in the same subject. Its base seems to be an albuminous substance very analogous to that in the saliva.(2) Perhaps its composition is not always the same, and varies from the nature of the substances which act on the inner membrane of the stomach. The action of this fluid, united perhaps with that of the bile, changes the food into a mucilaginous, gray, and thick pulp, of a disagreeable odor and taste, termed *chyme* (*chymus*). The nature of this pulp varies with that of the alimentary substances; it includes more solid parts and less of salts than any other of the animal fluids. It contains much carbon and albumen, but no gelatine, at least if we may judge from some experiments. It forms gradually in the pyloric portion.(3)

The formation of chyme, or the *digestion in the stomach*, is singularly favored by the closing of its two orifices. We must also mention among the causes which favor this process the motions of the stomach, which are at first vague and irregular, but which gradually take place about the end of chymification from the cardiac to the pyloric orifice.

I. SEXUAL DIFFERENCES.

§ 2155. The stomach is the only portion of the alimentary canal which presents sexual differences. It is larger, shorter, and broader in the male; smaller, narrower, and longer in the female. Its muscular coat, like that in the whole alimentary canal, is generally also thinner in the female.*

II. SMALL INTESTINE.

§ 2156. The *small intestine* (*intestinum tenue*,)(4) the narrowest and thinnest portion of the intestinal canal, is included between the sto-

(1) This opinion has at least become very general since the time of Spallanzani, although the experiments of Montègre tend to prove that it is not always correct. Prout asserts that the free or at least the unsaturated acid often existing in the stomach of animals is the hydrochloric, and that the salts commonly found in this viscus are the alkaline hydrochlorates (*Phil. trans.*, 1824, p. 1). Children has arrived at the same result by analyzing the fluids vomited by a man during a violent attack of dyspepsia (*Annals of philosophy*, 1824, July). F. T.

(2) Bostock, in the *Med. chir. trans.*, vol. iv., p. 177.

(3) Marcet, in the *Med. chir. trans.*, vol. vi., p. 627.—Prout, *Mémoire sur l'hematose et le sang en général*; in the *Journ. compl. des se. méd.*, vol. xi., p. 132–215.

* Beside the sexual differences, Dr. S. Th. de Sœmmerring has shown that the stomach of the negro differs from that of the European, in being of a more rounded form, approaching that of the ape (*Am. Med. Journal*, Nov., 1828).

(4) Helvetius, *Observations sur la membrane interne des intestins grêles, appelée veloutée, sur leur membrane nerveuse, et sur leur membrane musculeuse ou charnue*; in the *Mém. de Paris*, 1721, p. 392–403.—C. B. Albinus, *Descriptio intestinorum tenuium hominis*, Leyden, 1722, 1724.

mach and the large intestine. It is uninterruptedly continuous with both, although separated by two valvular folds, the pylorus and the ilieo-cœcal valve, the closing of which can perfectly insulate its cavity, which is sometimes the case.

Its outer circumference is uniform; this is also the case with its diameter in most of its extent, and hence it is cylindrical.

Its whole length from the pylorus to the commencement of the colon varies much from thirteen to twenty-seven feet, although the length of the body does not differ in the same proportion.

It is about an inch in diameter when moderately distended.

The description of the duodenum may be separated from that of the small intestine, as it differs from this latter in several respects.

A. DUODENUM.

§ 2157. The commencement of the small intestine, that portion directly next to the stomach, is called the *duodenum* from its length.(1)

This intestine is situated in the right half of the abdomen. It describes a considerable arch, the convexity of which looks to the right and the concavity to the left. We distinguish in it three parts, a *superior*, which ascends obliquely from left to right and a little from before backward; a *middle*, oblique from right to left and descending; finally an *inferior*, oblique from right to left and ascending.

It is attached to the gall-bladder and to the commencement of the transverse colon. Its upper and smallest portion is situated above, and the lower and largest, below the transverse colon. It is covered in most of its anterior face by the posterior wall of the peritoneum, which extends forward in this place to form the transverse mesocolon, surrounds it loosely, and keeps it fixed against the posterior wall of the abdominal cavity.

The middle portion descends below the transverse mesocolon, and when this fold of the peritoneum is raised it is seen on the right side of the mesentery.

The third, on the contrary, is situated on the left side of the mesentery, the upper part of which arises from it directly. It extends to the second lumbar vertebra, goes forward in the place where the upper extremity of the mesentery blends with the transverse mesocolon and opens into the jejunum.

If we except its first portion, which is covered in every part by the peritoneum, the duodenum is protected by this membrane only on its anterior side; the posterior is attached by a very loose cellular tissue to the posterior wall of the abdomen and directly to the organs situated behind it.

(1) L. Claussen, *De intestini duodeni situ et nexu*, Leipsic, 1757.—Sandifort, *Tabulæ intestini duodeni*, Leyden, 1780.

The middle portion descends along the concave edge of the right kidney and on the right side of the vertebral column to the fourth lumbar vertebra.

The inferior ascending portion is situated on the right side of the vena-cava and the right renal vessels, on the left side of the aorta, behind the upper part of the root of the mesentery, the superior mesenteric artery, and the great mesaraic vein.

Its left and concave portion closely embraces the right half of the pancreas.

§ 2158. The duodenum is generally broader at its origin than in any other part; its concave face is corrugated, its convex face is smooth and tense.

It differs from the other portions of the small intestine by its situation and the firm manner in which it is kept in place, and also by its greater extent and the less regularity of its folds.

B. MEMBRANES OF THE SMALL INTESTINE.

§ 2159. The small intestine is covered externally in all its extent by the peritoneum, and, except the duodenum, it is attached to the lumbar portion of the vertebral column by a long fold of this membrane, termed the *mesentery* (*mesenterium*).

Below this peritoneal tunic is the thin muscular membrane,(1) which is about a third of a line thick.

The external or longitudinal layer, although much thinner than the internal, with which it is very intimately united and which is never entirely deficient, surrounds the canal almost entirely.

The internal layer is transverse or rather oblique, and circumscribes it entirely.

The vascular membrane presents nothing remarkable.(2)

The small intestine differs from the other portions of the intestinal canal principally by the arrangement of its inner or mucous membrane.(3) The principal character which distinguishes this membrane is the singular increase of its extent and the greater development of its surface, compared with that of the external membranes, especially the muscular and the peritoneal tunics.

This enlargement depends on its folding from without inward, which gives rise to two kinds of folds, the great and the small folds.

The great folds are termed *valves* (*valvulæ*), and the small, *villosities* (*villi*).

(1) V. Malacarne, *Sulla structura anatomica delle intestine;* in the *Memorie della societa italiana*, vol. x., p. 27–62.

(2) B. S. Albinus, *Diss. de arteriis et venis intestinorum hominis*, Leyden, 1736.—J. Bleuland, *Vasculorum in intestinorum tenuium tunicis subtilioris anatomes opera detegendorum descriptio*, Utrecht, 1797.

(3) Helvetius, *loc. cit.*—D. G. Galeati, *De cribriformi intestinorum tunicâ;* in the *Comm. Bonom.*, vol. i., 1731, p. 359–370.

Both are developed principally at the upper extremity of the small intestine. They diminish much in number and size from the origin of this organ to its termination.

c. VALVES.

§ 2160. The valves are three lines high at the upper part of the small intestine.

They have a transverse direction, and most of them occupy the whole circumference of the intestine, so that they form circles which circumscribe it. But they divide once or twice in their course, and also communicate with each other by oblique or perpendicular elevations, which generally are less prominent and much shorter than they; three or four of them always exist between each pair of valves.

They are very numerous, being only a few lines distant from each other.

There are but very few at the lower part of the small intestine, but before entirely disappearing, they gradually diminish in elevation and breadth.

They are formed only by the inner membrane and by the vascular tunic of the intestine, so that they cannot move themselves, but they are floated by the motions caused by the muscular tunic in the fluids within the intestinal canal. When we cut the intestine, we observe that they are directed towards each other, so that if we immerse the organ in water they cover one another like the tiles of a roof.

Hence the term *valvulæ conniventes*, applied to them by Kerckring; but it is wrong to ascribe this discovery to this anatomist, from which error they have derived the name of the *valves of Kerckring* (*valvulæ Kerckringii*).

An artery and vein usually pass through the base of each valve.

These valves delay the course of the substances in the alimentary canal; hence their greater development at the upper part of the small intestine is curious, since the fluid contained in this portion possesses the most nutritious particles.

They are no less curious as a peculiar character of the human organism. Morgagni mentions their absence in some ruminantia.(1) We have also looked for them in vain in many mammalia of all orders, even among the apes. In fact several fishes present very analogous transverse valves, which are often very numerous; but they occupy the end of the intestinal canal in these animals, and they have no villosities. They present also this character in those reptiles in which we have seen them.(2)

(1) *Ep. an.*, xiv., p. 20.
(2) *Deutsches Archiv. für die Physiologie*, vol. iii., part ii.

We may then say, in order to express the preceding proposition more precisely, that man is the only being possessing both transverse folds and villosities in the small intestine, and alone presents the union of these two organic arrangements, which are found separately in other animals. In fact most mammalia and birds, as also some reptiles and fishes, present only the villosities, and but a few genera of the last two classes the transverse folds.

D. VILLOSITIES.

§ 2161. The *villosities*(1) are small thin prolongations, which are generally rounded, sometimes cylindrical, sometimes conical, and terminated insensibly in a point; finally, sometimes enlarged at their loose extremity; they are attached to the mucous membrane; hence, the term *villous tunic* (*tunica villosa*), often applied to it.

The villosities cover all the inner face of the mucous membrane of the small intestine, being very compact at its upper part, while at the lower part they are more or less remote from each other. In regard to their form, some authors, as Galeati, admit that they are cylindrical, or pointed at the origin of the intestine, and conical at its termination, but this difference is not constant. We have always found on the contrary, which agrees with the observations of Hewson, that the villosities at the upper part of the canal are broader in proportion to their length, and that from their form, they resemble the valvulæ conniventes, while as those of the lower part were thinner, elongated, and even sometimes longer than the preceding. They are about one quarter of a line long. As they are arranged very compactly, and as there are about four thousand in a square inch, we may estimate their whole number as more than a million, which is very moderate.

When examined by the microscope, they appear formed of a granular substance, and their surface is not perfectly smooth, although it is not indented. When the blood-vessels of the intestinal canal are injected, the villosities are not only more apparent and filled with injection, but their surface is more uneven, because a vascular net-work is developed in it.

When the lymphatics are injected, we see on their surface a net-work formed by these vessels.

They are then composed of cellular tissue, in which are blood-vessels and lymphatics, the parietes of which are not distinct from its substance. It has long been disputed, whether the villosities open on their surface or not?

(1) Beside the works of Helvetius, Galeati, and A. Meckel, consult particularly on the villosities:—J. N. Lieberkuhn, *De fabricâ et actione villorum intestinorum tenuium hominis*, Leyden, 1745.—Hewson, in his *Exp. inq.*, vol. ii. c. xii.—R. A. Hedwig, *Disquisitio ampullarüm Lieberkuhnii physica-microscopica*, Leipsic, 1797.—C. A. Rudolphi, in his *Abhandlungen*, &c. p. 39.

Excellent observers, as Lieberkuhn, Hunter, Cruikshank, Hewson, Hedwig, and Bleuland, admit these openings, and assert they have seen them. Lieberkuhn and Bleuland think there is generally only one at the extremity of each villosity, rarely several. Others mention more, and assert they are situated in the same place. When a minute injection has raised, inflated, and rendered the villosities cylindrical, they appear spungy, and perforated at their extremity, while they remain smooth and united on the sides. We cannot consider these openings as arising from accidental ruptures, since they are empty and entirely separated from each other, and they also occur only in determinate points, while in ruptures of a part, the vessels of which are filled with injection, we should necessarily see this injection. Cruikshank and Hunter have counted twenty of these openings in the villosities, which were not injected, but only gorged with chyle.

The arguments of Rudolphi who has never seen these openings, do not refute the assertions of the observers above mentioned. He does not mention Hewson at all. The diameter of the openings figured by Cruikshank and Bleuland, which seems too great to be correct, may depend on some individual peculiarity, on the state in which the activity was at the moment of death, or even on some disease, all which circumstances would render the openings more perceptible. If Hewson has not figured them in all the villosities, it may depend either on their diameter or on the situation of the villosities, and the manner in which they were lighted.

Thus, although these openings are not necessary to explain the phenomenon of absorption, they seem to exist.(1)

E. GLANDS.

§ 2162. The inner membrane of the small intestine is covered with numberless muciparous glands, which differ in their size and arrangement.

In its whole length, and on all its surface, there are very numerous distinct glands, which are the smallest (*G. mucosæ*, s. *cryptæ minimæ*), and which cannot be seen without a microscope.(2)

(1) Strictly speaking, the question is, whether the pores of the villosities, for they must necessarily exist in every organic or inorganic substance, possess a special organization, so that they may be compared to a certain extent with the lachrymal puncta for instance. But it is what it does not seem to be, and we cannot but apply to microscopical observations, where the illusions are so frequent and difficult to avoid, the axiom, that a negative assertion does not refute a positive one, when the latter is supported by good authority. The researches of A. Meckel, the brother of the author, also favor Rudolphi's opinion. This anatomist does not admit vessels in the villosities of the intestine, and thinks that the injection which penetrates into them, transudes through the parietes of the arterial terminations, to be distributed in the cellular tissue which forms them. Farther, he has found, contrary to the assertion of all his predecessors, that the villosities are always flattened layers, most generally turned on their axes, and often folded on each side, so as to form a semicanal or a groove, which arrangements vary infinitely, and by which he explains the different appearances described by authors before him. F. T.

(2) Galeati, *loc. cit.*—Lieberkuhn, *De villis intestinorum.*

Others are much larger, and divided into two classes, the *solitary* (*G. solitariæ*) and the *agglomerate* (*G. agminatæ*). The first are termed also the *glands of Brunner*,(1) and the others *the glands of Peyer*.(2)

The glands of Brunner are seen particularly at the commencement of the small intestine, especially in the duodenum, where they appear in the form of small, flat, rounded, lenticular bodies, at most one line in diameter, situated on the posterior face of the mucous membrane, and which open into the cavity of the intestine by broad orifices.

When these simple glands are very large, and project considerably above the inner face of this portion, or the other parts of the canal, it is always from a morbid state.

The glands of Peyer rarely exist except in the ileon, where they enlarge much from the commencement to the end of the intestine.

They form about thirty masses, which are generally oblong and rounded, seldom triangular or almost square, the longitudinal axis of which is parallel to that of the intestinal canal; they are rarely more broad than long, and they do not exist on the side of the intestine corresponding to the mesentery, but on the lateral portions, particularly the anterior.

They are not prominent, or at least project but little above the surface of the intestine, and they are distinguished only by the intestine being less transparent in the points they occupy. They form on the posterior face of the mucous membrane, a thin layer, which is composed of bright, transparent, rounded, and slightly depressed points, and of darker edges in the spaces between these points.

They vary in length from some lines to three or four inches; they are about nine lines broad.

At the upper part of the ileon they are five or six inches distant from each other; but at the lower part, and near its termination, they are almost blended with each other, and sometimes form in the loose portion of the edge of the small intestine, an almost uninterrupted layer eight inches long.

F. FUNCTIONS OF THE SMALL INTESTINE.

§ 2163. The inner membrane of the small intestine secretes the *intestinal mucus* (*mucus intestinalis*) and the *intestinal liquid* (*liquor entericus*), which probably form one and the same fluid, partially favoring the assimilation of the alimentary substances by its action upon them, and also their progress by the lubricating layer on the surface of the intestine. This progress is caused by the muscular tunic, which alternately dilates and contracts from the commencement of the small intestine to its termination, so as to send forward its contents in the

(1) Brunner, *Glandulæ intestini duodeni*, s. *pancreas secundarius*, Frankfort, 1715.

(2) C. Peyer, *De glandulis intestinorum*, Schafhouse, 1677.

same direction. In passing through the small intestine, but particularly in the duodenum, and from the influence of bile, aided by that of the pancreatic juice, the chyme is separated into two portions, the *chyle* (*chylus*), a whitish fluid, similar in its chemical properties to the blood and the *fœcal matter* (*fœces*). The chyle is absorbed by the villosities of the intestine, whence it passes into the lymphatic vessels, and probably also into the meseraic veins. The feces proceed into the large intestine.

III. LARGE INTESTINE.

§ 2164. The *large intestine* (*intestinum crassum*, s. *colon*) differs from the small intestine in its situation and attachments, form, length, breadth, and the arrangement of its tunics.

A. SITUATION AND ATTACHMENTS.

§ 2165. The large intestine describes an arch, the direction of which is from below upward, then goes transversely from right to left, and finally from above downward, begins at the lower extremity of the small intestine, and terminates at the anus. It commences at the right iliac region, but not always in the same point. This point is generally situated at the upper extremity of the anterior face of the right iliacus muscle, between this and the psoas muscle; sometimes, also, it occurs much lower, and sometimes much higher, before the right psoas muscle. The small and the large intestine are intimately attached in this place to the iliacus muscle by a short cellular tissue, and the first is there continuous from within outward, and from below upward with the second.

The higher, that is, the more abnormal the union between the two, the more similar the arrangement to that in the fetus.

At the point of union the commencement of the colon presents a prominence which extends below its terminating extremity, and is termed the *cœcum*, and the *cœcal appendix*.

B. DIVISION OF THE LARGE INTESTINE.

A. ILEO-COLIC VALVE.

§ 2166. The small intestine is suddenly continuous with the large, at the point mentioned, so that it enters there at an acute angle from below upward, from left to right, and from within outward, for about an inch, and there forms a prominence termed the *ileo-colic valve*, (1) or the *valve* of *Bauhin* (*valvula ileo-colica*, s. *Bauhini*). This valve is

(1) L. Heister, *De valvula coli*, Altdorf, 1718.—J. N. Lieberkuhn, *De valvulâ coli*, Leyden, 1739.—Haller, *De valvula coli*, Gottingen, 1742.—J. M. Rœderer, *De valvula coli*, Strasburg, 1768.

composed of two layers, a superior, generally a little narrower and almost horizontal, which forms nearly a right angle with the ascending portion of the colon, and an inferior, which is broader, and describes a more acute angle with this same portion.

Between the two layers is a transverse and oblong opening, which is the slightly contracted orifice of the small intestine.

Each is formed by the inner membrane of the vascular tunic, and the circular fibres of the muscular membrane of the large and the small intestine which are turned over in this place, while the longitudinal fibres, and the peritoneal tunic, which do not fold, pass like a bridge from the loose portion of the small intestine on the large. The muscular tunics of the two intestines are united with each other at their external face by mucous tissue, and when we consider only the valve, they form its most internal part or its centre. When we carefully destroy the cellular tissue which unites them, the valve entirely disappears, the small intestine opens directly into the large by a broader orifice than the rest of its caliber, in the form of a trumpet, and then the union of the two intestines still more resembles that of the esophagus with the stomach, since in both places the line of demarkation is evidently indicated by a very evident difference in the texture of the inner membrane, by the greater size of the lower portion into which the other opens, and by its projecting above this latter, giving rise to a cul-de-sac.

§ 2167. In the normal state the ileo-colic valve separates the small from the large intestine, so as to allow the substances contained in the first to pass into the second, but entirely preventing them from reascending from the latter into the former. This effect depends both on the action of the muscular fibres and the form of the valve.

B. CŒCUM AND VERMIFORM APPENDIX.

§ 2168. The portion of small intestine which passes beyond the colon, (§ 2166) is composed of the *cæcum* (*intestinum cæcum*), and of the *vermiform appendix* (*appendicula vermiformis*),(1) which originally form but one, and which do not begin to be distinct until after the early years of life.

§ 2169. The *cæcum* is elongated, triangular, and as large as the rest of the colon. It extends from an inch to an inch and a half beyond the terminating portion of the small intestine. The muscular fibres in particular, are very irregular, and very much interlaced near its closed extremity. It is terminated by a blunt summit, of which the *vermiform appendix* is the prolongation ;(2) the latter, however, rarely leaves its centre, but arises from its left side a little posteriorly. It is

(1) J. N. Lieberkuhn, *De valvula coli et usu processus vermicularis*, Leyden, 1739.—J. Vosse, *De intestino cæco ejusque appendice vermiformi*, Gottingen, 1749.—Van den Busch, *De intestino cæca ejusque processu vermiformi*, Gottingen, 1814.

(2) Louyer Villermay, *Observations pour servir à l'histoire des inflammations de l'appendice du cæcum ;* in the *Archiv. génér. de médecine*, vol. v. p. 246.

the narrowest part of the alimentary canal. A small fold of peritoneum unites it to the lower extremity of the mesentery, and to the spermatic vessels which are situated below it.

This appendix is generally about three inches long.

Excepting its orifice, which is a little broader than the rest, and tunnel-shaped, its breadth is nearly equal in every part, and is about two lines. It is terminated in a blunt summit. A transverse fold, a kind of valve, sometimes, but not always, separates it from the cœcum.(1)

Near the end of the cœcum, the three bands which form the longitudinal muscular layer of the large intestine, unite to form a thinner and uniformly expanded membrane, which is extended on the vermiform appendix, where it assumes the same arrangement.

§ 2170. The parietes of this appendix are as thick as those of the large intestine, and its inner membrane forms, from its great number of large and extremely compact muciparous glands, a very complex net-work, similar, although much larger than that formed by the inequalities of the inner face of the rest of the colon.

Not unfrequently, although not always, this inner face also presents larger transverse prominences, folds similiar to those at the orifice of the appendix.

The vermiform appendix is not always situated exactly in the same place; it sometimes descends almost entirely into the pelvis, the edge of its mesentery opposite to that which adheres to it, being loose. Sometimes it goes upward, passing under the commencement of the large intestine. Sometimes then it assumes this ascending direction in its whole extent, and sometimes its lower extremity again curves downward in a greater or less extent.

c. ASCENDING COLON.

§ 2171. The large intestine begins with the *right* or *ascending colon* (*I. colon dextrum*, s. *ascendens*), which is its shortest portion, ascends before the right kidney, with which it is intimately united by the *right lumbar meso-colon*, and extends to the anterior part of the lower face of the right lobe of the liver. In this place it describes a right or an acute angle under the base of the gall-bladder, with which it has normally no connection, goes to the right, and is continuous with the transverse colon.

d. TRANSVERSE COLON.

§ 2172. The *transverse colon* (*colon transversum*) is attached to the posterior wall of the abdomen by a much broader fold of the peritoneum than that of the preceding, termed the *transverse meso-colon*; it is situated below the stomach, with which it is always more or less intimate-

(1) Morgagni, *Advers. anat. Anim. XIV.*—Bonazzoli, *Observ. in intesi. et renibus habitæ*; in the *Comm. Bonon.*, vol. ii. p. 2. p. 138.

ly united by the great epiploon, and always descends more or less before the folds of the small intestine, usually to the umbilical region, sometimes even into the small pelvis. It is always much longer than the ascending colon, and sometimes very much exceeds it in size, and then describes several circumvolutions. It extends from the right to the left side. Its two extremities are intimately attached to the duodenum by the meso-colon, which is much shorter in these two parts than in its centre. On the centre of the anterior face of the right kidney, and at the lower extremity of the spleen, it is continuous with the descending colon, describing either an arch, or a more or less acute and sometimes a double angle.

E. DESCENDING COLON.

§ 2173. The *descending colon* (*I. colon descendens*) extends from the lower extremity of the spleen to the pelvis, passing along the lower half of the anterior face of the left kidney, then the quadratus lumborum muscle, and finally the upper and inner part of the left iliacus muscle. It is continuous with the rectum before the right sacro-iliac symphasis.

It is attached to the posterior wall of the abdomen, above by a short, and below by a very large fold of the peritoneum.

This lower part projects more or less forward, and to the right, and sometimes adheres to the cœcum; it describes a curve, hence it is called the *S*, or *sigmoid flexure of the colon* (*flexura sigmoidea*, s. *iliaca*, s. *S. romanum*).

F. RECTUM.

§ 2174. The *rectum* (*I. rectum*) is the last portion of the intestinal canal, and it opens externally by the anus. It begins at the lower extremity of the colon, is attached to the left half of the anterior face of the sacrum in a slight portion of its upper extremity, by a short fold of the peritoneum, termed the *meso-rectum*, and in the rest, simply by cellular tissue; it goes from left to right, and from above downward, so long as it is surrounded by the peritoneum, and does not begin to descend in a straight line until this membrane leaves it.

Sometimes it descends in the pelvis on the right, and not on the left side of the sacrum. In one case of this kind observed by us, the great inferior left curve or the sigmoid flexure of the colon, advanced very much toward the right, united very intimately at its centre with the commencement of the ascending colon, and was attached in this manner to the right side. Its ascending and descending portions were also attached and separated a little from each other inferiorly. Below this point, the commencement of the curve and that of the rectum were also united by a fold of peritoneum, whence there was a considerable depression, which might easily receive a portion of small intestine several inches long, and thus give rise to an internal hernia.

Although we may justly consider the rectum as the lower part of the large intestine, the rectum differs from it in several respects. In fact:

1st. It is almost always much broader, and in this respect it exceeds more or less the other portions.

2d. The peritoneum covers it only in its upper region; even there it covers, in most of its extent, only its anterior face, and forms no epiploic appendages on its surface.

3d. Its muscular fibres are much stronger, and the longitudinal layer surrounds it in every part.

The inner membrane is also smooth and filled with simple muciparous glands, but these glands are smaller and fewer.(1)

(1) The recto-vesical operation for stone, introduced by Sanson, which becomes more extensively known every day (J. L. Sanson, *Des moyens de parvenir à la vessie par le rectum*, Paris, 1817), requires a more detailed description of the anatomical relations of the rectum. Taken as a whole, this intestine extends from the upper strait of the pelvis to the anus. Its direction is at first a little oblique from left to right, and it curves toward the lower part of the cavity of the pelvis to go from behind forward, under the bladder, to the level of the prostate gland, below which it again curves from above downward, and a little from before backward. We may then consider it formed by three parts separated by these two curves, and distinct in their situation and structure, and the nature and importance of their connections. The first or superior is directed from above downward, and a little obliquely from left to right; it extends from the end of the sigmoid flexure of the colon to the place where the intestine leaves its peritoneal envelop, and curves to go below the bladder; it forms more than half of the rectum. It is tortuous, loose, smooth, covered by the peritoneum, and attached loosely to the posterior wall of the cavity of the pelvis by a fold of this membrane. The second or central part is included between the two curves, and is about three inches long; its direction is oblique from above downward and from behind forward; it is slightly curved in the same direction, is fixed and immovable, and constantly corresponds posteriorly to the lower part of the sacrum, the coccyx, and the base formed by the ischio-coccygei muscles: forward to the base of the bladder, from which it is separated downward and outward by the seminal vesicles and the vasa deferentia, and still lower by the prostate gland: finally, on the sides to an abundance of cellular tissue. It differs in structure and organization from the upper portion, being wholly destitute of the peritoneum, except sometimes at the highest part of its anterior face, when the bladder is considerably retracted; its muscular coat also is much thicker, and formed of much stronger and more numerous longitudinal fibres; it is every where surrounded by a cellular tissue, compact only below the prostate gland, loose and very abundant in the rest of the circumference of the intestine. Finally the lower portion of this latter commences below and on a level with the prostate gland, and terminates at the anus. It varies in length from one inch to an inch and a half. It is broader above than below. Its direction is oblique from above downward, and a little from before backward. Near its origin it is every where surrounded by an abundant cellular tissue, except forward, where it corresponds to the prostate gland; in the rest of its extent it is enveloped by the sphincters. Its structure differs much from that of the other portions. In fact, when the rectum curves a second time below the prostate gland, its fleshy tunic, which is very thick, and composed of numerous longitudinal fibres, terminates suddenly; the mucous membrane alone extends to the skin, surrounded by the round muscular fibres of the sphincters, which meet and form a kind of ring, much thinner at its origin than on the side of the skin, where it becomes much thicker, and gives rise to two caudiform prolongations, of which the anterior, the longer, goes toward the bulb of the urethra, and there blends with the bulbo-cavernosus muscle, while the posterior proceeds to the coccyx. This muscular ring is covered internally by the end of the mucous tunic of the intestine, is united forward and upward to the prostate gland, and is adapted in every part to very abundant and fatty cellular tissue. Thus the upper portion of the

C. FORM.

§ 2175. The large intestine is not uniformly cylindrical like the other sections of the intestinal canal, but presents numerous elevations and depressions, which render its surface uneven. In fact the longitudinal fibres are there united in three bands separated by spaces, and the muscular membrane considered generally is shorter than the inner tunics. Hence it follows, that when the cavity of the large intestine receives the residue of digestion, it forms between the three bands three series of rounded bursæ which vary in size, and are termed *cellules* (*cellulæ*, s. *haustra*).

These bursæ are all similar but are not perfectly alike, and are no where arranged symmetrically. Their origin from the cause mentioned proved by the fact that on cutting the bands the inequalities disappear in the place corresponding to the incision, and the canal there possesses a perfectly cylindrical form.

D. LENGTH AND BREADTH.

§ 2176. The length of the large intestine is about five feet, and its breadth when moderately distended varies between an inch and a half and two inches.

E. ARRANGEMENT OF THE TUNICS.

A. PERITONEAL COAT.

§ 2177. In most of its extent, especially in its ascending and descending portions, the large intestine is covered by the peritoneum only forward and on its sides and not on its posterior face, which is attached to the adjacent parts only by very loose cellular tissue. The transverse portion, on the contrary, is every where surrounded by the peritoneum. From the loose portion of the peritoneal coat arise the *epiploic appendages* (*appendices epiploicæ*).

B. MUSCULAR MEMBRANE.

§ 2178. The muscular membrane of the large intestine, except the rectum, is thinner even than that of the small intestine. It is composed, as in every other part, of longitudinal and of transverse fibres.

rectum is movable, and covered by the peritoneum, while the middle and inferior parts, forming together about at least four inches, are surrounded in every part by an abundance of cellular tissue, and are attached, but have no peritoneal envelop.
F. T.

The longitudinal fibres distinguish the large intestine from all the other portions of the intestinal canal in this respect, that generally speaking, they are united in three bands, situated at nearly equal distances from each other, about from four to six lines broad, which gradually increase in thickness from the circumference to the centre. One of these bands is situated posteriorly, and corresponds to the point where the intestine is kept in place by the peritoneum; the second is anterior, and proceeds in the middle portion below the insertion of the epiploon; the third occupies the inside of the ascending and the descending portion, and the lower side of the transverse portion, where it is perfectly loose. All terminate at the vermiform process and in the longitudinal fibres of the rectum.

The thickness of the muscular tunic of the large intestine is diminished by the insulation of its longitudinal fibres.

The bands are much thicker the greater the number of these fibres, from which they arise.

They are about half a line thick, so that the thickness of the muscular tunic is considerable in the parts which correspond to them.

We also find at intervals between these three bands several distinct fasciculi of longitudinal fibres; and in subjects where the muscular system is very much developed, the large intestine is entirely surrounded by a layer of these fibres, always arranged, however, so that the intermediate fibres are much weaker than the three bands.

The circular fibres constantly surround the whole of the intestine, but they are much feebler than the longitudinal.

C. MUCOUS MEMBRANE.

§ 2179. The mucous membrane is perfectly smooth when considered superficially, but when examined attentively we observe that it is uneven, from numerous small, rounded, oblong, compact depressions, similar to the points of pins. These depressions give it a shaggy or honey-comb appearance, as is seen on the inner face of the mucous membrane of the stomach.(1) The elevations between them occupy a greater space than they, and may be considered as corresponding to the villosities of the small intestine.

The arrangement of the inner membrane of the two sections of the intestinal canal differs extremely at the place where they unite, and these two sections are separated by a very distinctline of demarkation, although uninterruptedly continuous with each other.

We cannot determine whether the function of these depressions is to secrete, any more than the other parts. We know, however, that they are not surrounded by a substance different from that of the rest of the mucous membrane; but this latter appears more thin and more transparent in these points than in the intervals between them.

(1) This has already been observed by Hewson (*Exp. inq.*, pt. ii., p. 174).

The mucous membrane of the large intestine presents a great number of mueiparous glands, whieh are distinet or united in pairs or in triplets, and situated near eaeh other. These glands represent small depressions with a more or less elevated edge. They are very evident in intestines hardened by alcohol, beeause then the inner membrane is contracted, and assumes a brownish eolor. They are formed partly by the union of several of the smallest glands.(1)

F. MUSCLES OF THE ANUS.

§ 2180. The lower extremity of the rectum is subject to the influenee of the will, and is moved by several museles, the *sphincters*, the *levatores ani*, and the *transversi perinei* museles. We shall deseribe here only the sphineters, referring the history of the others to the ehapter on the genital organs, with whieh they are more intimately connected than with the anus.

§ 2181. The anus has two *sphincters*, an *internal* and an *external*, both of whieh result from a greater development of the circular fibres of the rectum.

A. SPHINCTER ANI INTERNUS.

§ 2182. The *sphincter ani internus* musele proves very evidently the origin above mentioned; for the longitudinal fibres of the rectum are defieient from three to four lines, the cireular fibres become redder and thicker, have the form of a flattened ring, whieh extends beyond the longitudinal fibres. This ring is three or four lines high and about two lines thick, and it is situated directly under the skin.

B. SPHINCTER ANI EXTERNUS.

§ 2183. The *sphincter ani externus* musele is mueh stronger than the preeeding, and although a distinet musele, exaetly surrounds it. It is situated under the skin, to whieh it adheres very intimately. It is thin and flat; its internal fibres are less arched than the external, and the anterior and the posterior unite at an acute angle. Its anterior and posterior extremities are pointed.

The posterior extremity is attached to the posterior face of the last piece of the coeeyx either direetly or by a compact eellular tissue.

The anterior blends with the transversus perinei muscle, and usually also in man with the posterior extremity of the bulbo-caver-nosus, in the female with the eonstrietor vaginæ musele. But sometimes also it terminates in the perineum, either by fleshy or by tendinous fibres, and does not extend to either of these two muscles.

(1) Galeati, *loc. cit.*, fig. 3.

In the male it is more oblong, and its greatest diameter extends from before backward; in the female it is more circular, and at its anterior part it is broader and stronger. These differences undoubtedly depend on those which exist in the two sexes in the form of the pelvis and the external organs of generation.

G. FUNCTIONS OF THE LARGE INTESTINE.

§ 2184. The large intestine absorbs the small quantity of nutritious substance still contained in its contents, and sends the rest toward the anus. In this course the fœces gradually become harder and more solid. The action of the muscular membrane finally expels them, overcoming the resistance of the sphincters with or without the concurrence of the will. This expulsion always occurs periodically.

B. DIFFERENCES DEPENDING ON DEVELOPMENT.

§ 2185. Of all the parts in the abdominal cavity the intestinal canal is formed first; its mode of development and the changes in its situation, form, and volume, present equally remarkable phenomena.(1)

A. MODE OF DEVELOPMENT.

§ 2186. In respect to the mode of development one part is most intimately connected with the formation of the whole fetus, but particularly with that of the intestinal canal, and must consequently be mentioned first: we mean the *umbilical vesicle* (*vesicula intestinalis*, s. *umbilicalis*). It is a small, more or less rounded pouch, situated between the chorion and the amnion, and is probably much larger in proportion to the fetus the more recent the period of conception. It is even greater than the fetus during the early periods of gestation, and we have reason to think that it is always formed before it. It extends first to the anterior face of the body of the fetus, which rests directly upon it. But gradually and even early in the first month of gesta-

(1) C. F. Wolff, *De formatione intestinorum;* in N. C. Petrop, vol. xii., p. 1768.—Oken, *Anatomisch-physiologische Untersuchungen, angestellt an Schweinsfötus, Schweinsembryonen und Hundsembryonen zur Lösung des Problems über das Nabelbläschen*, &c., in Oken and Kieser, *Beytragen*, Hamburgh, 1806, 1807.—J. F. Meckel, *Abhandlungen aus der menschlichen und vergleichenden Anatomie*, Halle, 1806.—Id., *Beytrâgen zur vergleichenden Anatomie*, Halle, 1808, vol. i., pt. i., no. 5.—Id., *Ueber die Divertikel*, in Reil, *Archiv. für die Physiologie*, vol. ix.—D. Kieser, *Der Ursprung des Darmkanas aus dem Nabelbläschen*, Gottingen, 1810.—Hoechstetter and Emmert, *Ueber das Nabelbläschen;* in Reil, *Archiv. für die Physiologie*, vol. x.—Fleischmann, *Leichenöffnungen*, Erlangen, 1815, p. 1–75.—J. F. Meckel, *Sur la formation du canal intestinal dans les mammifères et en particulier dans l'homme;* in the *Journ. compl. du dict. des sc. méd.*, vol. ii., p. 119 and 289.—L. Rolando, *Sur la formation du canal alimentaire et des viscères qui en dépendent;* in the *Journ. compl. des sc. méd.*, vol. xvi., p. 53.

tion, it diminishes much, and is situated farther from the fetus, so that in the second month it is on the outside of the umbilical cord.

Do the parietes of the umbilical vesicle and the intestinal canal primitively communicate? Several anatomists of great merit(1) think that this communication is demonstrated neither in the fetuses of the mammalia generally nor in that of man in particular. The following facts, however, render this opinion very probable:

1st. The analogy with birds, reptiles, and cartilaginous fishes, to the vitelline membrane of which the umbillical vesicle corresponds perfectly,(2) and in which it is proved that the communication in dispute exists at all periods of fetal existence.

2d. We sometimes perceive in very young fetuses a canal which goes across the umbilical sheath, from the vesicle to the abdomen, and by which we can at pleasure empty the vesicle of this fluid, and fill it again.(3)

3d. We always find in the fetus, until the commencement of the fourth month, blood vessels which go from the mesentery to the umbilical vesicle, unite first on this latter, but gradually extend only to the anterior wall of the abdomen, and finally die, and are ruptured or entirely effaced. These are the *omphalo-mesenteric* vessels (*vasa omphalo-mesaraica*), comprehending an artery and a vein, which arise from the mesenteric vessels.(4)

These vessels also exist in birds, where they go to the yolk, proceeding along the vitelline canal.

4th. The intestines are at first very near the umbilical vesicle, and are situated out of the abdomen in the umbilical sheath, which at this period really makes part of the abdominal cavity.(5)

It is not unfrequent, proportionally speaking, to find in the full grown fetus a canal which extends from the intestine to the umbilicus, which opens in this latter place, and is always attended by the omphalo-mesenteric vessels.(6.)

It is then very probable, though not certain, from all these facts, that the umbilical vesicle and the intestinal canal originally communicate. There are, however, others which really demonstrate the existence of this communication.

Thus we have mentioned above a human fetus five lines long, in which we saw distinctly a filament attached to the umbilical vesicle

(1) Emmert.—Hoeschstetter.—Cuvier, *Ann. du Muséum*, vol. iii.

(2) Needham, *De form. fœtu*, London, 1667, p. 79.—Blumenbach, *Spec. phys. comp. inter anim. cal. sang. ov. et viv.*, Gottingen, 1789, p. 11.—Sœmmerring, in Haller, *Grundriss der Physiologie*, vol. ii., p. 799, 800.

(3) Hunter, *Anatomische Beschreibung des schwang. Uterus*, p. 68.

(4) Meckel, *Handbuch der pathologischen Anatomie*, vol. i., p. 563.—We have since verified this remark in at least ten fetuses of this age.

(5) Meckel, *Abhandlungen*, 1806, p. 301.—Oken, *Beyträge*, 1806, ch. ix.

(6) We have collected, in the first volume of our *Hand. der Path. Anatomie*, all the known cases of this anomaly, one of which we observed and described (Reil, *Archiv. für die Physiologie*, vol. ix).

and extended to the intestine, and we have figured this communication as it exists in fetuses of sheep and cows,(1) since admitted by Bojanus also in the fetuses of sheep.(1)

Men, however, of high authority, doubt it. Emmert, Hœchstetter, and Cuvier, assert that there is no continuity of substance between the two organs, and that the communication existing between them, is established only by the omphalo-mesenteric vessels. In fact, they admit, beside these vessels, a third filament, extended between the vesicle and the intestine, but they do not consider it as a canal of union, but only as a simple prolongation of the peritoneum. The following are the arguments in support of their opinions:

1st. The impossibility of passing water or any other fluid from the vesicle into the intestinal canal.(3)

2d. The great difference between the white and thick substance of the alimentary canal, and the thin reddish membrane of the vesicle, and also the pellucid and delicate membrane which unites these two organs, and accompanies the omphalo-mesenteric vessels.(5)

But we may reply to the first objection, that the phenomenon on which it rests depends perhaps on the narrowness of the canal, and also on the thinness of the vesicle, and demonstrates at most the absence of a *hollow* canal of communication, the admission of which is not absolutely necessary, since the intestinal canal of several animals is solid at intervals, in the normal state.

The second objection also loses its weight, when we consider that the allantoid membrane and the urachus vary at least as much from the bladder, and we observe as great, or even greater constant differences between different parts of the same system. This remark is more reasonable, since we have found the opening of the communication greatest in sharks, where the differences between the vitelline membrane and the intestinal canal were most distinct. Farther, the differences are also considerable in the cases last mentioned.

We think then that we must at present admit a continuity of substance between the umbilical vesicle and the intestinal canal, without pretending to decide if the cavities of the two organs open into each other.

From the analogy of the development of the intestinal canal in the fetuses of birds, this canal is formed in the following manner. The vitelline membrane, which is at first in direct contact with the vertebral column, begins by forming a small prominence on each side, so that originally, the intestine, which has the form of a groove, opens anteriorly.

(1) Muller, *De genitalium evolutione*, Halle, 1815, fig. 1–2, p. 11.

(2) *Sur la vésicule ombilicale du fœtus de brebis;* in the *Journ. compl. du dict. des sc. méd.*, vol. ii., p. 84.—Dutrochet, *Recherches sur les enveloppes du fœtus;* in the *Mem. de la soc. méd. d'émulation de Paris*, 1816; and a note to the *Réflexions du professeur Emmert sur la vésicule ombilicale*, in the *Journ. compl. des sc. méd.*, vol. ii., p. 369.

(3) Emmert, in Reil, *Archiv für die Physiologie*, vol. x. p. 52.

(4) Emmert, *loc. cit.*, p. 75.

This groove gradually forms, by the increase of its parietes, from behind forward, from above downward, and from below upward, to the place where the cavity of the intestine communicates with the vitelline sac by the vitelline canal, the diameter of which always diminishes.(1) Oken's opinion, that the intestinal canal should be considered as a kind of excrescence of the umbilical vesicle, which enters already formed into the abdomen from above and from below, is less probable, and is unsupported by facts.

§ 2187. Does the intestinal canal always communicate with the umbilical vesicle in one determinate point? What is this point?

First, this canal is continuous with the vesicle by its anterior edge, but very probably the point to which the communication is finally confined, always corresponds to a determinate place, although it may vary in a certain extent.

Two such points have been mentioned. Oken thinks it is the point of union between the large and small intestine. He considers the vermiform appendix and the cœcum as the result and the remains of this communication.(2) In this view of the subject, the umbilical vesicle in collapsing, and the intestinal canal on descending deeply into the abdomen, produce a contraction, a kind of neck, the parietes of which approach, and are finally blended. This separates the intestine from the umbilical vesicle. The canal then enters into the abdominal cavity, where the situation of the intestines, hitherto parallel, necessarily changes, so that the anterior joins the neck at an angle, and the neck becomes a prolongation of the posterior, which preserves its former direction. Hence, according to Oken, the upper intestine seems to penetrate into the lower, the angle of union becomes the ileo-cœcal valve, and the neck gives rise to the cœcum and its vermiform appendix. But,

1st. We do not see why the contraction of the intestine, and their entrance into the abdomen, necessarily result in causing the upper part of the intestine to enter into the lower, and form a vermiform appendix. This is still less probable, inasmuch as the cœcum and the ileo-colic valve are rarely deficient in man from a primitive deviation of formation, while they are normally absent in many mammalia provided with an umbilical vesicle; while others, in whom the cœcum is very large, have no vesicle. The great differences in the length and structure of the cœcum, render Oken's opinion very improbable. It is even more probable, on the contrary, that the consequence of such a formation would be a simple uninterrupted canal.

(1) Wolff demonstrated long since the manner in which the intestinal canal was formed by the vitelline membrane, in birds, after very correct and careful observations, made at an useful time, that is, at a period very near its first formation. As Needham, Blumenbach, and Sœmmerring, have demonstrated the identity of the vitelline envelop and the umbilical vesicle, Oken had no right to claim, as he has done (*Beytragen zur vergleichenden Anatomie*, 1806.—*Lehrbuch der Naturgeschichte*, 1815, p. 3), the honor of having discovered in the envelops of the fœtus of the hog, that the intestinal canal is formed from the umbilical vesicle.

(2) *Loc. cit.*, part ii. p. 85.

2d. The cause to which Oken attributes this change does not exist; for the cœcum is formed long before the intestines pass into the abdomen, and is itself inclosed in the umbilical sheath.

3d. If the cœcum was the point where the intestine was detached from the umbilical vesicle, it would also be the most anterior part of the intestinal canal, and the nearest to the vesicle. But this never occurs, for we always find a fold of the small intestine before the vermiform appendix. Oken, it is true, has figured the contrary, according to his idea, that in man the intestines must detach themselves from the umbilical vesicle,(1) but unfortunately this does not exist in nature.

§ 2188. Oken's opinion is still less admissible, since arguments unite to render it very probable, that the communication between the intestine and the umbilical vesicle always exists in a determinate, but very different place from that mentioned by him. This place is in the small intestine, and nearer its lower than its upper extremity.

The arguments in support of this second opinion, all of which are opposed to the theory of Oken, are the following:

1st. The canals between the intestine and the anterior wall of the abdomen, always proceed from this point.

2d. In one rare case, in a full grown fetus, monstrous from the development being arrested at several times, there was a real umbilical vesicle inserted in this canal.(2)

3d. In this part of the canal, the vitelline canal in birds and reptiles terminates.

4th. We find as the normal formation in most birds, and perhaps also in some mammalia, and not unfrequently as an anomaly, in this part, and never in any other, in man and other mammalia, a single rounded prolongation, varying in length and breadth, and surrounded by the same membranes. This prolongation, termed the *diverticulum*, is evidently a trace of the primitive canal of communication; it is frequently attended both in the fetus and adult, with the remains of the omphalo-mesenteric vessels.

Very probably, there is a period in the existence of the human fetus, when a similar small tubercle exists regularly, after the umbilical vesicle is separated from the intestine. Having found a very large diverticulum attended by the omphalo-mesenteric vessels in four human fetuses three months old, which we had occasion to examine at nearly the same time, we have reason to think that the appendix continues regularly until this period, that is, long after the intestinal canal has entered the abdomen.(3) But we now renounce this opinion, although it has been refuted by no one. If a diverticulum really exist for some time as a normal formation, it disappears long before the end of the third month of gestation, since we have seen the cœcum in the seventh week, although there was no trace of a diverticulum; whence it follows,

(1) *Loc. cit.*, p. 84. vol. iv. fig. 14.
(2) Tiedemann, *Anatomie der kopflosen Missgeburten*, tab. iv.
(3) *Handbuch der pathologischen Anatomie*, vol. i. p. 565.

that the omphalo-mesenteric vessels continue much longer than it. But this circumstance does not prove that the diverticulum never exists normally, or that Oken's opinion of the cœcum is correct.

5th. This is the point whence the omphalo-mesenteric vessels depart to go into the umbilical sheath, after, and even before the intestines have entered the abdomen.

6th. In all these cases one or two normal cœcums always exist in the part where the large intestine unites with the small.

These different arguments seem to us to render the insertion of the umbilical vessels on the ileon much more probable than that of this organ, in the point mentioned by Oken. The diverticulum sometimes found, depends either on an abnormal want of energy in the formative power, or on the fact, that the neck of the umbilical vesicle, which perhaps commonly dies on the surface of the intestine, does not then disappear except in a greater or less extent.

Although these arguments were published long since, Oken still continues to maintain that the cœcum is the part where the intestinal canal is detached from the umbilical vesicle,(1) and he lays it down as a principle either to oppose us, or to support his opinion: 1st, that there is never but one cœcum; 2d, that the cœcums of birds do not deserve this name, and are only appendages of the bladder; 3d, that the cœcum exists in all mammalia, and in all birds and fishes who lay large eggs, while it is so small as to be invisible in a very few of these animals, the eggs of which are small;(2) 4th, that this organ is the old vitelline canal. As these assertions are published in an elementary work, they deserve to be examined, although it is easily seen that they are totally unfounded.

In establishing his four laws, Oken has forgotten, 1st, of those mammalia which possess two cœcums, as the dama and the phascolomys; 2d, the coexistence of the canal of the umbilical vesicle, the diverticulum, and the cœcum, in the mammalia and birds; 3d, the perfect resemblance in the mammalia and birds, in the relations between the cœcums, the vitelline canal, the diverticulum, and the rest of the intestinal canal, since the cœcums always exist on the limit between the large and the small intestine, while this is never true of the canal and the diverticulum; 4th, the absolute want of facts, establishing that the intestinal canal unites with the vesicle by the cœcum, while there are a great number proving that it always occurs near the lower part of the small intestine; 5th, the fact that the volume has no effect on the deficiency of the large or small size, and the other conditions of the cœcum, since it is very large in most mammalia, and is entirely deficient in many birds. Even when we admit that the diverticulum of birds is the cœcum, which, however, is impossible, his third law would still be refuted. His third remark, " that the cœcum exists in all mam-

(1) *Zoologie*, 1815, vol. i. p. 2.
(2) *Loc. cit.*, p. 10.

malia, &c., but it is so small, as to be invisible in a very few of these animals," is difficult to understand.

Oken has also brought forward in favor of his hypothesis:

1st. The arrangement of the cœcums in fishes, in which the vitelline sac of the superior animals is divided into several culs-de-sac.

2d. The formation of the chondropterygia,(1) in which the cœcum arises distinctly from the vitelline sac.

One cannot suppose that he himself believes these two arguments to be valid: for

1st. Comparative anatomy demonstrates most positively, that the cœcums of fishes are pancreatic glands, and no one has hitherto attempted to compare them to the vitelline membrane, which also exists in these animals.

2d. The cœcum of the chondropterygia is found at the end of the large intestine, and the vitelline canal at the end of the small intestine.

3d. The vitelline canal is broadly open in the fetus, and exists at the same time as the cœcum, and is entirely separate from it. This latter continues during life, while the canal entirely disappears.

We then have cause to retain our opinion, as it is also supported by respectable authorities, as Tiedemann,(2) Cuvier, (3) Dutrochet,(4) and Jæger.(5)

B. SITUATION.

§ 2189. The situation of the intestinal canal varies at different periods, as one may conclude from the details already mentioned. Although it forms on the anterior face of the vertebral column, it is, however, generally further from it in most of its extent, during the early periods of existence than subsequently. At first only a small portion of its upper and lower extremities exist in the proper abdominal cavity; all the rest is inclosed in the umbilical sheath, which for this or for other reasons, is then extremely large, and should be considered as a prolongation of the abdomen. At first the upper and lower extremities of the intestinal canal extend in a straight line, side by side, and describe an angle to communicate together; but gradually, at the seventh week of gestation, they proceed backward, begin to become tortuous, and reunite in a fold before the umbilical opening. Only the small intestine is tortuous, the large intestine is perfectly straight, and its blunt extremity, the cœcum, goes forward, but always far behind the anterior extremity of the small intestine.

About the middle of the third month, the intestinal canal enters entirely into the cavity of the abdomen, where the lower part of the small

(1) *Isis*, 1818, p. 20.
(2) *Anatomie der kopflosen Missgeburten*, p. 66.
(3) *Isis*, 1818, p. 138.
(4) *Loc. cit.*
(5) *Deutsches Archiv für die Physiologie*, vol. iii. p. 543.

intestine is the last to proceed. At this period, and sometime after, the canal, especially the large intestine, varies as much as before from the arrangement it will afterwards normally possess. In fact, the large intestine is not formed of three portions, two lateral, which are perpendicular, and a middle transverse portion, the right of which is attached to the organs behind it only by a short fold of the peritoneum; but it is formed at first by a single perpendicular portion, attached by a long mesentery, to the centre of the posterior wall of the abdomen. This portion is gradually reflected from right to left at its summit; it then descends on the right, so that the union of the great and small intestine does not correspond to the right lumbar region until toward the end of the fourth month. For a long time, and until birth, the descending colon describes in the left iliac region, a greater curve than it does in the adult, which undoubtedly depends on the narrowness of the pelvis.

The situation of the stomach differs primitively from that assumed by it in the adult, as it is at first almost perpendicular. The duodenum is detached from it, and goes directly downward and forward without any curve. When the liver diminishes in size, and the intestines enter the abdomen, the stomach and the duodenum gradually change their situation, and assume that which they afterward retain.

C. DIMENSIONS.

§ 2190. The intestinal canal is much shorter and narrower the younger the fetus is. At first it is no longer than the vertebral column, on the anterior face of which it is developed. It then becomes more extensive, and extends always in a straight line into the umbilical sheath, but when it becomes longer, it is tortuous, being situated in a narrow space.

The small is much broader in proportion to the large intestine, the younger the fetus is. In this respect, the relation between them is opposite to that which exists in the adult, for the small intestine, for a long time, is much greater than the large, and even in the full grown fetus the latter is frequently not at all or but little broader than it.

On the other hand, the large intestine is much longer in proportion to the small, the younger the fetus is. This difference undoubtedly depends on the fact, that the small intestine is much shorter in proportion to the body in the early periods than in the adult.

The cœcum and the vermiform process are at first very small, but soon increase considerably, so that they are proportionally much larger and broader than they are subsequently. They are not originally separated in the same manner as in the adult; the cœcum is not enlarged before it is continuous with its appendix; the latter is not as narrow, but represents the extremity of the large intestine, which is extended in a cul-de-sac above the ileon, gradually contracting a little on itself.

As the cœcum first appears in man, the mammalia, and birds, as a small tubercle, which gradually enlarges, and of which there is not the least trace at first, this circumstance alone demonstrates that it is not formed in the manner mentioned by Oken, but by an enlargement of the large intestine. Before it appears, there is no mark of difference between the large and the small intestine. The ileo-colic valve is at first imperfect and very small; it however begins to appear at the third month of gestation, and it is perfectly developed in the full grown fetus.

D. FORM.

§ 2191. The intestinal canal during its development, differs considerably in its form, and in the arrangement of its membranes.

We have already mentioned the differences which occur in the cœcum, when speaking of those in dimension. We must add the following remarks:

1st. The stomach is at first much longer and more rounded than when the development is completed. The great cul-de-sac does not exist originally, and it afterwards is larger than in the adult.

2d. The outer face of the large intestine is perfectly smooth until toward the end of the fifth month. The enlargements, which are the sources of its great size, appear first in the transverse colon.

Of the intestinal tunics, the internal particularly presents differences relative to the development of the organ.

1st. It is more uniform in the different regions of the intestinal canal during the early periods of life than subsequently. Of this we may be easily convinced by examining the valvules or the villosities.

a. The villosities do not appear before the third month of gestation. At this time they are seen first along the whole intestinal canal, in the form of longitudinal folds, the surface of which is indented, and which, like the indentations, gradually increase in number. Such is the origin of the villosities. When they are developed in this manner, they exist also in the large intestine till the seventh month of gestation, although their length is less at three months than in the small intestine, and it diminishes, as well as their number, from month to month, in which respect, the two regions of the intestinal canal are at first perfectly similar.

b. The valvules of the jejunum do not exist until the seventh month; they are even in the full grown fetus but slightly prominent, and easily effaced by compression.

These two peculiarities are curious, as they are analogous to what occurs in animals.

2d. The inner membrane of the stomach is thicker, and more easily separated from the others in the early periods of fetal existence than subsequently; it is less easy to insulate it entirely in the form of a perfect sac.

ARTICLE THIRD.

INTESTINAL CANAL IN THE ABNORMAL STATE.

§ 2192. The abdominal portion of the alimentary canal presents numerous anomalies in its form and texture.(1)

I. DEVIATIONS OF FORMATION.

A. PRIMITIVE DEVIATIONS OF FORMATION.

§ 2193. The primitive deviations of formation belong principally to the class of those which affect the quantity.

Among those of the first class, which essentially consist in an imperfect development of the formative power, or a continuance in the peculiar type of the fetus, may be arranged the following, some of which certainly belong to this class, and others may probably be arranged in it.

1. GENERAL DEVIATIONS.

1st. *Absence.* This deviation of formation relates principally:

a To the *stomach*, especially in acephalia vera, where the intestinal canal generally terminates in a cul-de-sac at its upper part, and is seldom enlarged. Sometimes a portion of the stomach also is deficient, particularly the pyloric valve, which is wholly or partially absent.(2)

b. To the *small intestine.* It is deficient, wholly or partially, in acephalia vera, in which we often observe that the large intestine, or only the lower part of the small intestine exists.

c. To the *vermiform appendix*, which is sometimes, though rarely, deficient, even when the rest of the canal is not abnormal.

d. To the *ileo-colic valve*, which is then simply replaced by some strong muscular fibres.

e. To the *large intestine.* Here the anomaly exists in several degrees, which are commonly attended with an *imperforate anus*,

(1) A. Monro, *The morbid anatomy of the human gullet, stomach, and intestines*, Edinburgh, 1811.—A. D. Stone, *A practical treatise on the diseases of the stomach, and of digestion.* London, 1816.—T. A. Hare, *View of the structure, functions, and disorders of the stomach and alimentary organs of the human body*, London, 1821.—G. Law, *Observations on derangements of the digestive organs, and some views of their connection with local complaints*, Edinburgh, 1821.—Scoutetten, *De l'anatomie pathologique en général et de celle du canal digestif en particulier*, Paris, 1822.—Andral, *Recherches sur l'anatomie pathologique du canal digestif*, Paris, 1823.

(2) Fleischmann, *Leichenöffnungen*, p. 100–102.

(*atresia ani*), because it usually attends this last deviation of formation.

Very rarely the large intestine is entirely deficient, existing only as a small appendix in the form of a cul-de-sac of the small intestine. Next in respect to frequency, come those cases, in which a small portion of the large intestine is deficient, so that the communication between the large and small intestine is uninterrupted; finally, that where the large intestine is developed to the entrance of the pelvis, but where there is no rectum. Sometimes the rectum partially exists, but it terminates in a cul-de-sac, and the space between it and the lower extremity of the colon is also closed in a cul-de-sac.

In this case the rectum sometimes opens into the vagina (*atresia vaginalis*), the bladder (*a. vesicalis*),(1) or the urethra (*a. urethralis*), so that a real cloaca is at the same time formed.

2d. *Diminution in diameter.* This anomaly exists in several degrees; in the greatest degree it constitutes *imperforation* (*a. vera*). It is always attended with the absence of a part, since on account of this defect, the part existing terminates in a cul-de-sac.

It occurs principally in the anus, where it varies much in degree. Sometimes the opening of the rectum is closed only by a thin membrane, sometimes this intestine is replaced entirely by cellular tissue, or by a full and solid cord.

Next comes the large intestine, which is imperforate at a greater or less distance above the anus. The ileon and colon more rarely terminate in a cul-de-sac.

Still more rarely, the same exists in the small intestine, either in some part of its course, or at its upper extremity, or occurs in the stomach, preventing a communication with the small intestine, or finally exists in several points of the intestinal canal.

Strictures(2) (*a. spuria*) are most frequent in the rectum and anus. They seem, however, not to be rare in the stomach, where they present remarkable peculiarities. In this case the stomach is most generally divided by a contraction near its centre, into two sacs, a right, narrower and more elongated—a left, larger and more rounded. The upper part of the left sac is usually not concave, but very convex, and the form of the two curves, particularly the inferior, are very much enlarged, the second presenting a deep groove. The esophagus is always inserted at the usual place, and the cul-de-sac is never enlarged. The degree of contraction varies much, from half an inch to five inches, judging from the five cases now before us; but the right half of the viscus preserves its normal direction. However, in one case we saw it turned on its axis, so that the convexity looked upward and forward,

(1) Cavenne, *Observation d'une imperforation de l'anus, avec ouverture de l'intestin dans la vessie*; in the *Archiv. génér. de méd.*, vol. v. p. 63.—J. G. Hasselmann, *De ani intestinirumque atresia*, Utrecht, 1819.

(2) Boyer, *Remarques et observations sur quelques maladies de l'anus*, in *Journ. compl. des sc.méd.*, vol. ii. p. 24.—G. White, *Observations on strictures of the rectum*, Bath, 1820.

and the concavity downward and backward, and descended here before the right end of cardiac half.

More rarely the stomach is divided by a second contraction into three sacs, of which the third undoubtedly arises from an unusual separation of the cavity of the pylorus from the rest of the cavity of the organ.

All these anomalies are curious, as analogous with animals. They occur principally in females.

When they exist, the texture of the stomach is unaltered in the contracted portion. This circumstance, however, is not sufficient to justify the opinion mentioned at the commencement of the paragraph, that this state constitutes a primitive deviation of formation, and farther, because, as we have already mentioned, the stomach contracts transiently at the same place during digestion, and causes of different kinds might render permanent an arrangement which should be transitory. The greater frequency of this anomaly in females, is equally favorable to the two opinions. We then have reason to think that the contraction in question does not always occur in the same manner, and this conjecture is rendered still more probable, as it is sometimes congenital, and attended with other deviations of formation, which mark an arrest of development.(1)

Not unfrequently, from a primitive deviation of formation, the stomach is no larger than the intestine, in which case it cannot be dilated.

We might probably mention here a valvular contraction of the left orifice of the stomach, which is very curiously attended with the absence of the pyloric valve.(2) If, however, this anomaly was not confined to a simple contraction, we ought rather to refer it to the deviations of formation dependent on an excess of the formative power.

3d. *Shortness.* Occurring sometimes in the whole of the intestinal canal, but most frequently in the vermiform appendix of the cœcum only.

II. SPECIAL DEVIATIONS.

§ 2194. The special deviations of primitive formation are :

1st. In the stomach.

a. The absence of the base, which we have once observed in a child two months old, where the cul-de-sac of the pylorus was much larger than that of the cardia, which was hardly visible.

b. Its perpendicular situation, which does not always depend on the abnormal enlargement of the liver, or on any other mechanical cause.

2d. In the intestinal canal.

a. The prolapsus of this canal into the umbilical sheath in a case of exomphalos. Instances of this anomaly are most frequent in the small

(1) Sandifort, *Obs. anat. path.*, vol. iii. p. 11.
(2) Fleischmann, *Leichenöffnungen*, p. 100.

intestine, as when the development is normal, this portion of the canal enters last into the abdomen.

b. The more or less perfect continuance of its primitive connection with the umbilical vesicle.(1)

This anomaly exists in several different degrees.

Sometimes the umbilical vesicle continues beyond the usual time, and communicates with the ileon by an open canal which the omphalo-mesenteric vessels(2) attend.

Sometimes only a canal exists; it varies in length, and extends from the same point of the ileon to the umbilicus, where it opens, and the omphalo-mesenteric vessels also accompany it.(3)

Finally, sometimes a greater or less prominence exists in this place, a prolongation termed the *diverticulum of the ileon*, this is often accompanied by the omphalo-mesenteric vessels, which float loosely at its extremity, or which are attached to the umbilicus or to another region of the intestinal canal, so as to form a plexus.

These three anomalies are only different degrees of the same deviation of formation. This is proved by their appearing always in the same place, by their connections with the omphalo-mesenteric vessels, and finally, the insensible shades which each presents in respect to length and size.

That they have the signification we attribute to them, is proved: 1st, by our history of the development of the intestinal canal, by their constant co-existence with the cœcum and vermiform appendix, and finally, by the fact, that they always have the character of a primitive formation.

That they depend on a primitive formation, is proved by the facts, that they are always observed in the same place, that they are formed by all the membranes of the intestinal canal, and that they exist simultaneously with other primitive deviations of formation, which arise from the development being arrested, or which, at least, favor their productions.

All these circumstances united, demonstrate that it is impossible to regard them purely as accidental productions,(4) and consider them as excrescences,(5) or as contractions,(6) or hernias(7) of the ileon.

In fact, the following arguments have been opposed to our theory of the diverticula of the ileon.

(1) Meckel, *Beyträge zur vergleichenden Anatomie*, vol. i., pt. i., 1808.—Id., *Ueber die Divertikel*; in Reil, *Archiv für die Physiologie*, vol. ix. part iii.—Id., *Handbuch der pathologischen Anatomie*, vol. i. p. 553-597.—Fulling, *Diss. de diverticulo intestinali sex mensium embryonis herniam umbilicalem referente*, Marburg, 1807.—Regnault, *Observation d'un cas singulier de volvulus*; in the *Journ. univ. des sc. Méd.*, vol. ii. p. 108.—P. Rayer, *Cas mortel d'entérite et de péritonite, déterminé par un diverticule de l'iléon*; in the *Archiv. gén. de méd.*, vol. v. p. 68.

(2) Tiedemann, *Anatomie der hopflosen Missgeburten*, p. 66. tab. iv.

(3) Meckel, in Reil, *loc. cit.*, vol. ix.

(4) Oken, in *Jenæer Literaturzeitung*, 1815, no. 35.

(5) Fleischmann, *loc. cit.*

(6) Littre, Mery, in *Mém. de Paris*, 1700-1701.

(7) Fabricius and Morgagni, in Morgagni, *Ep. an. méd.* 34, *a.* 17.

a. Their inconstancy,(1) their variety,(2) while all the transitory formations do not entirely disappear when the development is regular, and also the vitelline canal in birds always continues.

b. The existence of several diverticula in the same intestine, or at least that of real diverticula in parts of the intestinal canal beside the ileon.(3)

c. Their frequent coexistence with deviations of formation by doubling or arrest of development.(4)

d. The great size and thickness of their parietes, which even did a canal of the umbilical vesicle exist in the early periods of life, would indicate an excess in the formative power.(5)

But we have already opposed most of these objections before they were brought forward, and it is easy to refute them.

The first proves nothing, for several other deviations of formation, which consist essentially in the development being arrested, are still more rare than the diverticula, and disappear entirely when the development is regular. We shall mention, for instance, the permanence of the pupillary membrane, the absence of the extremities, the continuance of the arterial canal, the urachus, and the omphalo-mesenteric vessels, the fissure of the uterus. The analogy with birds, which has been adduced, is valueless, since even in several birds, as those of prey, the vitelline canal always seems to disappear entirely, and we commonly observe traces of the primitive state longer in the lower animals than in the higher classes.

Against the second objection, the extreme rarity of the anomaly on which it is founded, may be adduced. Farther, we may ask, if among these extremely rare cases, there are not some false diverticula; if in others, the diverticulum is not produced by distension; if in others, it does not depend on the union of the intestinal canal with the umbilical vesicle at an unusual place; finally, if the deviation of formation cannot be developed as a primitive anomaly, differently from that which commonly occurs, although it is impossible to conclude any thing from it against this latter.

The third objection favors our views, and is opposed to the theory it is adduced to support; since even where the whole body is double, some organs alone very rarely present the same tendency, for instance, a supernumerary finger or eye is not common in this case; while, on the contrary, the imperfect formations, especially those depending on suspended development, as the fissure of the vertebral column, the skull, the palate, and the abdomen, the deviations in the formation of the heart and the intestinal canal by defect, are then very common phenomena.

(1) Oken, in *Jeanœr Literâturzeitung*, 1815, no. 26.
(2) Emmert, *Reflexions sur la vèsicule ombilicale;* in the *Journ. compl. des sc. mèd.* vol. ii. p. 369.
(3) Emmert, *loc. cit.*
(4) *Id., ib.*
(5) *Id., ib.*

The fourth objection is not more valid than the other three, since the difference between the thickness of the parietes and the size of the cavity of the diverticulum, depend on the period when the development is suspended, or on other accidental circumstances, which exert their influence afterward. The oval foramen is no less an anomaly, whether it is an inch or a line in diameter, and accidental mechanical influences may sometimes enlarge it during life.

c. The great size of the vermiform appendix, depending on its continuing to increase after the type of the fetus, although this anomaly may be developed at a later period.

§ 2195. The deviations of formation, which essentially consist in an excess of the formative power, are much more rare than those we have mentioned.

We should probably consider as such the division of the duodenum into two canals, the existence of two vermiform appendices, doubtless, also the unusual length of the intestinal canal, instances of which are seen particularly in the large intestine, and which render it more or less tortuous, and especially render the transverse colon pendant.(1) Perhaps we must also refer to this class the real diverticula which occur in other unusual points, although we have every reason to think that they should be considered as belonging to those deviations of formation relating to the quality.

§ 2196. The primitive deviations of formation which concern the quality, relate to the form or situation, or to both. Among the latter, we must arrange the lateral inversions of the stomach and intestinal canal, since in this case, the parts are not only situated opposite their usual place, but also present a figure the inverse of that they normally possess.

The form of the stomach or the intestinal canal, rarely presents primitive deviations of formation in respect to quantity; and the examples known of them may all be referred to anomalies in the diameter.

The situation of the stomach is sometimes changed, this viscus being turned on itself so that its convex edge looks upward, and its concave edge downward.(2)

B. ACCIDENTAL DEVIATIONS OF FORMATION.

§ 2197. The accidental or consecutive deviations of formation relate to the extent, the mass, the situation, or the form.

1st. Extent.

a. Excess in extent rarely occurs in the whole abdominal portion of the alimentary canal, but it is observed in all its parts, and it is produced by very different causes, that is, particularly by obliteration, contrac-

(1) P. Monterossi has figured a great many cases of this kind at the end of a memoir *on the unusual curves of the large intestine, considered as the cause of death in new born children*, in Brera, *Nuovi commentari di medicina*, 1819, vol. iv. p. 3.

(2) Fleischmann, *loc. cit.*, p. 98.

tion, atonia, the latter always from an accumulation of substances within it.(1)

The abnormal distension of the vessels of the alimentary canal, which not unfrequently exists, deserves to be mentioned here. It is most generally observed in the rectum, in the form of rounded tumors, which project into the cavity of the intestines, and are termed *hæmorrhoids.*(2) It is generally admitted that these tumors are situated in the hæmorrhoidal veins; doubtless also, the arteries contribute to them, although we cannot admit with Cruveilhier, that they are new formations, an accidental development of the erectile tissue. More probably, they depend in some cases on the dilatation of the small vessels, and in others, on that of the larger vessels, and in the last case, where they appear as sacs, the dilated portion is separated from the rest of the vessel.

The vessels of the stomach are generally dilated in melena, and the black substance vomited, or which is found in the stomach, is blood more or less changed, which has transuded through their extremities.

b. Abnormal contractions, when not primitive, are rarely confined to a simple deviation of formation. They generally succeed alterations of texture, inflammation, and its consequences, effusion, scirrhus, &c. The first commonly occurs when the alimentary canal is not distended by the causes which habitually act upon it, consequently after long fasts.

The whole canal is affected. A contraction occurs also in a portion of this canal situated below a solution of continuity which entirely divided it, consequently when an artificial anus is formed after a wound or strangulated hernia.

2d. We more seldom find an increase or diminution in *mass* without an alteration of texture; the first occurs particularly in the muscular tunic, and supervenes when this membrane has been unusually exercised. Thus it is more rare to find the stomach dilated than very muscular in gluttons. The muscular membrane is similarly changed in a herniary portion of intestine.

The muscular tunic becomes much thinner in a general loss of flesh.

3d. *Situation.* Deviations in situation should be referred to the chapter on hernias, since they generally occur in these affections. The small intestine is particularly liable to a change in its situation, on account of its greater mobility, its smaller size, and its situation. Next comes the stomach, which generally emerges through the linea alba or the upper part of the abdominal muscles, sometimes, however, through the umbilical ring. When abnormal openings exist in the

(1) Chaussier, *Observation suivie de reflexions sur une dilatation excessive de l'estomac;* in the *Bulletin de la soc. méd. d'émul.*, 1823, September, p. 505.

(2) Montegre, *Des hémorrhoides*, or *Traité analytique de toutes les affections hémorrhoidales*, Paris, 1819.—E. Summe, *Diss. de hæmorrhoidibus œcis*, Berlin, 1820.

(3) *Anat. pathol.*, vol. ii. p. 145.

diaphragm, they allow the stomach to pass into the cavity of the thorax.

4th. The principal changes in form are:

a. Inversion, in which one portion of the intestine is turned, so that its inner face becomes the external, and the outer face the internal. When this change occurs at the lower part of the rectum, it is termed a *prolapsus ani.* In every other part it is called *intussusception* or *invagination*, because the inverted part enters that below it. The first state is more simple, since the portion of intestine which forms the prolapsus is composed of two parts, situated one on the other, the external of which is reversed and the internal is normal, while in the second case is added a third, that into which the inverted portion enters. Sometimes we find a still greater number of superimposed layers, there being two invaginations, one within the other.

Several invaginations often occur at the same time.

They are most frequently situated in the small intestine, undoubtedly because it is the most movable portion of the alimentary canal.

Even those intussusceptions which commence very high may descend into the rectum and emerge from the anus.

The most common cause of this state is the irregular action of the muscular membrane. Sometimes, however, it is caused mechanically by tumors, which force a portion of the intestinal canal downward and inward.

Slight invaginations are doubtless not dangerous, and disappear of themselves; but when they exist to a greater extent they cause inflammation and gangrene of the herniary portion, which is usually, but not always, attended with death; sometimes, however, the gangrenous portion sloughs off, and the space is filled by adhesive inflammation.

5th. Solutions of continuity result either from mechanical influence, as the action of a cutting instrument, a rupture, or from a previous alteration of texture, as from ulcerations. They are sometimes complete, and then affect all the tunics, sometimes confined only to the muscular and peritoneal membranes, whence results a hernia of the inner membrane, and the formation of a rounded tumor termed a *false diverticulum* (*d. spurium*). The false differs from the true diverticulum by its rounded form, by the absence of several superimposed tunics, and finally by its occurring in every part, even in the stomach, but most frequently in the duodenum, and by the existence of several at once.(1)

II. ALTERATIONS OF TEXTURE.

§ 2198. We not unfrequently observe an alteration in the texture of the intestinal canal, particularly in the stomach, which is its *softening*

(1) We have enlarged upon this subject in our *Handbuch der pathologischen Anatomie*, vol. ii., p. 11.

or *thinness*, and when occurring in a still greater extent its *perforation*.(1) This alteration is seen particularly in the large cul-de-sac and in the posterior wall of the stomach, and commences by the inner membrane, which always appears very red in this place. The edges of the perforation are very irregular, and differ from those of a perforation caused by an ulcer by the total absence of thickening and hardness of the edges, which are, on the contrary, very thin and soft. Sometimes this change supervenes after death; sometimes it occurs during life, but in both cases it is caused by the action of the gastric juice on the stomach, and we may consider it as resulting from the digestion of the membranes of the stomach by this juice, which effect results when the perforation occurs during life from some change in the chemical composition of the gastric fluid.(2)

(1) Chaussier has given a good description of perforations of the stomach; we shall quote his words. Ulcerations and perforations of the stomach vary in form, situation, and extent. They are small and circular, or large enough to introduce the hand into them. They may occur in any part of the stomach, but are seen particularly at the base of this organ, in the portion corresponding to the spleen and diaphragm. Sometimes then the food enters into the abdomen, or the thorax if the diaphragm be perforated. But most generally there is no effusion, the ulcerated portion of the stomach being connected with the adjacent parts. If we destroy these adhesions, which are slight, a viscous, and sometimes a fluid, flows from the stomach, which is not fetid, and sometimes has an odor like musk; it is always brownish, and mixed with blackish flaccule or molecules, as if finely pulverized charcoal was strewed in mucous serum. The edges are soft, broken, and sometimes surrounded with a more or less marked blackish line. In every other part the stomach preserves its usual form and consistence. It no where presents marks of engorgement or inflammation: only the capillary plexuses of its follicular membrane seem to be more developed, especially around the perforation. Sometimes these changes form suddenly in a few hours in healthy persons; most generally, however, after several days of sickness, and when no violent external cause or poisoning can be suspected (*Bulletin des sciences médicales du département de l'Eure*, no. 53. p. 7). Consult also on this subject which relates to one of the most important questions in legal medicine: Gerard, *Des perforations spontanées de l'estomac*, Paris, an. xii.—Morin, *Considerations générales sur l'érosion*, Paris, 1806.—G. Laisne, *Considerations médico-légales sur les érosions et perforations spontanées de l'estomac;* in the journal called *Médecine légale*, Paris, 1819, p. 135.—J. Cloquet, *Sur les perforations intestinales;* in the *Nouveau journal de médecine*, vol. i. p. 107.—Serres, *Observation d'une perforation de l'œsophage;* in the *Revue médicale*, vol. x. p. 166.—Id., *Observations de perforations intestinales;* same journal, vol. x. p. 170.—E. Legallois, *Plusieurs perforations du canal intestinal et spécialement des gros intestins, à la suite d'une affection tuberculeuse;* in the *Archiv. gén. de méd.*, vol. vi. p. 68.—Louis, *Du ramollissement avec amincissement et de la destruction de la membrane muqueuse de l'estomac;* same journal, vol. v. p. 5.—Abercrombie, *Observations sur l'inflammation et l'ulcération de l'estomac;* same journal, vol. v. p. 447.—Louis, *Observations relatives aux perforations spontanées de l'intestin grêle, dans les maladies aiguës;* same journal, vol. i. p. 17.—U. Coste, *Observations sur les perforations de l'estomac;* in the *Journ. univ. des. sc. méd.*, vol. xxix. p. 257. F. T.

(2) This is the opinion of Hunter. We cannot admit it. It rests on Hunter's opinion in accordance with that of Spallanzani, in respect to the gastric juice. But it is very evident that the gastric juice does not exist, as these two physiologists have supposed, that it does not accumulate in the stomach between meals, that it is secreted only at the moment when the viscus is filled with food, that this secretion is caused by the impression produced by the latter, and so far from being identical, it always varies according to the nature of the substances from which the chyme is found. Besides, perforation of the stomach has never been observed, in the cases of death by starvation hitherto observed, and that cited by Hunter should be referred

When the stomach is thus destroyed in one part, the softening produced by the effused fluid extends also to the adjacent portions.(1)

§ 2199. The alimentary canal frequently *inflames*,(2) especially in its mucous membrane.

In regard to the inflammation of the stomach, we ought to remark that the inner membrane of this viscus, which is the most subject to inflammation on account of the numerous vessels it receives, the formative power it possesses, its connections with the skin, and the direct effect of deleterious substances upon it, often presents, when not inflamed, a very deep red color, which depends on an accumulation of blood in the small twigs of the veins, and is observed particularly after death, from those causes which favor the stagnation of blood in these vessels by opposing its return to the heart.

In inflammation of the mucous membrane, the mucus becomes thicker and firmer. At the same time the fibrin is effused on the inner face and in the substance of this membrane. The result of the first of these phenomena is, the formation of more or less thick, hollow, or solid cylinders, which pass off from the anus, and which have been wrongly considered as the membranes of the intestine. The effect of the second is, to thicken the parietes, and thus to contract the cavity of the canal. In the latter case partial adhesions sometimes, but rarely, occur, and probably arise from ulcerations.(3)

In ulcers of the mucous membrane, the edges are usually lightly turned over, uneven, and hard; sometimes also their edges are smooth, and, as it were, cut.

Inflammation and suppuration frequently form *fistula of the anus* (*fistula ani*), that is, a canal which commences on the inner face of the rectum, descends on its sides, and terminates near the anus. Like all fistulous passages, this canal is covered internally by an epidermis, similar to the mucous membranes, and is surrounded with a dense cellular tissue.(4)

In dysentery, where the inflammation is situated principally in the mucous membrane of the large intestine, especially of the rectum, this membrane frequently mortifies in several parts, and black and dry eschars are formed on its surface.

to the erosions mentioned in the preceding note. Consult on this subject F. G. Gœdecke, *De dissolutione ventriculi, sive de digestione quam dicunt ventriculi post mortem*, Berlin, 1823. F. T.

(1) Yelloly, *Observations on the vascular appearance in the human stomach, which is frequently mistaken for inflammation of that organ;* in the *Med. chir. trans.*, vol. iv. p. 374–425.

(2) Scoutetten, *Recherches d'anatomie-pathologique, démontrant le rapport qui existe entre l'irritation de la membrane muqueuse du canal intestinal et celle de la méningine;* in the *Journ. univ. des sc. méd.*, vol. xxviii., p. 257.

(3) Monro, *Morb. anat.*, tab. vii.

(4) J. Howship, *Practical observations on the most common diseases of the lower intestines and anus*, London, 1820.—C. Bell, *A treatise on the diseases of the urethra, vesica urinaria, prostata, and rectum*, London, 1820.—T. Copeland, *Observations on the principal diseases of the rectum and anus*, London, 1814.

All these phenomena are usually confined to the mucous membrane. The tubercular formation, however, in which rounded, whitish, and hard masses are formed, extends from this membrane to the outer face of the organ, where it forms more or less evident prominences. This change is commonly observed in the latter period of tuberculous phthisis, especially in the small intestine. The ulcerations thus affect all the membranes of the stomach, and then gradually extend from within outward. They do not necessarily result in the effusion into the abdomen of substances contained in the organ; this is even proportionally rare on account of the adhesions with the adjacent parts, or because the opening communicates with another portion of the intestinal canal, or with the exterior, when the wall of the abdomen adheres to the diseased organ.

Inflammation of the peritoneal coat of the alimentary canal is often followed by more or less general and intimate adhesions between the different parts of the passage. These adhesions are sometimes so numerous and intimate that the folds of the intestines form one mass, which cannot be separated from the surrounding substance, and represents only a canal hollowed in an amorphous mass.

One of the most common alterations of texture in the intestinal canal is the scirrhous formation, which extends from the vascular tunic and the muciparous glands, where it is primitively situated, to the mucous and muscular membranes. It blends together all these tunics, and renders them thicker and harder; they finally present a carcinomatous ulceration.(1) This alteration of structure causes a contraction of the canal, which is often very great. It is observed more particularly in the pylorus, the end of the descending colon, and the rectum, which depends perhaps only on the disposition of these parts to retain for a longer period the substances which pass through them, and are also more exposed to irritation and its consequences. But the morbid affection extends also a greater or less distance to its primitive source, so that it sometimes attacks the whole stomach and a very great portion of the intestinal canal.

Very probably we must arrange here the morbid alterations described by Monro, in which albumen is deposited in the vascular tunic, for all its essential characters are the same, and it differs from cancer only in its form, since it appears as small rounded bodies.(2)

The fungous excrescences of the mucous membrane are much more rare. They have however been found in every part of the intestinal canal. Thus authors have described some cases of very large polypi of the stomach, one of which extended from the cardiac orifice even within the duodenum.(3) We have lately found in the cadaver of a

(1) Bourdon, *Observations sur quelques maladies de l'estomac;* in the *Revue médicale*, May, 1824.

(2) *Morbid. anat.*, p. 17.

(3) Breschet, *Tumeur polypeuse développée dans l'estomac;* in the *Bull. de la fac. de méd.*, vol. v., 1817, p. 376. Other cases of this kind may be found in Monro, *Morbid anat.*, tab. vi.—Fabre, *Gazette de santé*, June, 1815.

young man frequently affected with abdominal affections, and who died of violent enteritis, two excrescenees of the mucous membrane of the small intestine, one of which was about four lines in diameter, and was covered in all parts by the mucous membrane, while the other, about an inch in diameter, had destroyed this membrane, and was unattached. These excrescences are more common in the rectum(1) than in any other part. They are similar only in form, for they differ much in respect to texture; since they are sometimes very hard and solid, sometimes spungy, and of a loose and soft tissue. The first probably belong to the class of fibro-cartilages, and the others to that of fungus hematodes.

A tumor of the internal membrane, described by Monro as a *milt-like* tumor, and which affects the stomach particularly, is doubtless a fungus hematodes.(2)

In fact, in examining the viscera of individuals who have died from a severe attack of small-pox, we have found the inner membrane of the intestinal canal very red, but have never seen in it pustules.

The normal tissues are rarely formed abnormally in the intestinal canal. We must however mention here, the fatty tumors developed on the inner face of the mucous membrane,(3) the hairs which are found sometimes alone on the inner face of the intestine,(4) sometimes attended with teeth, in the stomach,(5) the ossifications of the inner face of the intestine,(6) and finally, at least in certain cases, hemorrhoids, when they are cavernous formations.

§ 2200. *Foreign bodies* of different kinds are common in the abdominal portion of the alimentary canal, particularly in the intestine.

Those seen most frequently are the intestinal worms, which in fact are more common here than in any other part of the body. The ascaris lumbricoides, the tœnia lata, s. bothryocephalus latus, and the tœnia solium, live principally in the small intestine, the trichocephalus dispar in the large intestine, and particularly in the cœcum, finally the ascaris vermicularis, oxyuris vermicularis, Bremser, in the large intestine, and particularly in the rectum.

These worms exist in the stomach only accidentally, and generally even not till after death. The openings through which they sometimes pass into the peritoneal cavity are not formed by them.

Other foreign bodies, which are much more rare, are concretions introduced accidentally into the intestinal canal. They are most com-

(1) Meckel, *Handbuch der pathologischen Anatomie*, vol. ii., pt. ii., p. 511.—Laracine, *Observation sur une tumeur fongueuse pédiculée dans le rectum*; in the *Bull. de la soc. méd. d'émul.*, September, 1821.

(2) *Morbid anatomy*, p. 160.—Rullier, *Sur le cancer de l'estomac*; in the *Archiv. gén. de méd.*, vol. ii., p. 380.

(3) Meckel, *Handbuch der pathologischen Anatomie*, vol. ii., pt. ii., p. 124.

(4) Meckel, *Mémoire sur les poils et les dents qui se développent accidentellement dans le corps*; in the *Journ. compl. des sc. méd.*, vol. iv., p. 122, 217.

(5) Ruysch, *Advers. anat.*, dec. iii.

(6) Meckel, *Handbuch der pathologischen Anatomie*, vol. ii., pt. ii., p. 227.

monly biliary calculi, which descend into it from the gall bladder. Next come the abdominal concretions, which form partially or wholly in the intestine.(1)

ARTICLE FOURTH.

GLANDULAR ORGANS OF THE ABDOMINAL PORTION OF THE DIGESTIVE SYSTEM.

§ 2201. The glandular organs of the abdominal portion of the digestive system,(2) termed also, together with the stomach, the *chylopoietic viscera* (*viscera chylopoietica*), are the *liver*, the *pancreas*, and the *spleen*. They are situated in the upper half of the abdomen, and are intimately connected with each other, and with the stomach and the duodenum, not only in situation but also in the vessels and nerves they receive, but even, except in the spleen, in continuity of substance. In fact they receive their vessels from the same trunk, the cœliac artery; their nerves come from the same source, the solar plexus; finally, the excretory canals of the liver and pancreas, which open into the duodenum, are in fact folds of the inner membrane of this intestine.

I. LIVER.

A. PERFECT STATE.

a. SITUATION.

§ 2202. The liver (*hepar*, *jecur*),(3) the largest gland in the body, occupies all the right hypochondriac region, the upper part of the epigastric region, and in the female particularly, part of the left hypochondriac region. It descends on the right side lower than on the left,

(1) Meckel, *Remarques sur les concrétions qui se rencontrent dans le canal intestinal chez l'homme;* in the *Journ. compl. des sc. méd.*, vol. ii., p. 125.

(2) J. Fantoni, *De jecore, liene et pancreate;* in the *Disc. renov.*, Turin, 1745.

(3) A. Rolfink, *De hepate*, Jena, 1633.—F. Glisson, *Anatomia hepatis*, London, 1654.—M. Malpighi, *De hepate;* in the *De viscerum structura*, Bologna, 1666.—J. B. Bianchi, *Historia hepatica*, Turin, 1711.—A. Bertrandi, *De hepate et oculo*, Turin, 1748.—A. Franken, *Hist. hepat. anat.*, Leyden, 1748.—J. G. Gunz, *Obs. circa hepar*, Leipsic, 1748.—A. Ferrein, *Sur la structure des viscères nommés glanduleux, et particulièrement sur celle des reins et du foie;* in the *Mém. de Paris*, 1749, p. 709.—M. Ambodick, *De hepate*, Strasburg, 1775.—F. A. Walter, *De structura hepatis et vesiculæ fellæ;* in the *Annot. acad.*, Berlin, 1786.—Saunders, *A treatise on the structure, economy, and diseases of the liver*, London, 1798.—J. M. Mappes, *Diss. de penitiori hepatis humani structura*, Tubingen, 1817.—Id., *Quelques considérations sur la structure du foie et du rein;* in the *Journ. compl. des sc. méd.*, vol. xii., p. 223.—J. F. Beltz, *Quædam de hepatis dignitate*, Berlin, 1822.

so that it is situated obliquely from below upward, and from right to left. On the left side it terminates near the upper extremity of the spleen; its left portion covers the stomach, the right generally the whole right kidney, but when the latter organ is situated lower than usual, only its greater upper half.

B. DIMENSION AND WEIGHT.

§ 2203. The transverse diameter of the liver in the adult is usually from ten to twelve inches; the antero-posterior is from six to seven inches. The gland is two inches high in its thickest portion.

The liver generally weighs about four pounds in the adult, so that its weight in proportion to that of the whole body is as 1 : 36.

C. FORM.

§ 2204. The form of the liver is irregular and quadrangular. It is much thicker from one side to the other than from before backward, and is thinnest from above downward.

§ 2205. The liver is generally divided into two *halves* or *lobes* (*lobi*), the right and the left, separated on the upper face by the suspensory ligament, on the anterior edge by a deep groove, and on the lower face by a deep longitudinal fissure, which extends the whole breadth of the gland.

§ 2206. The *right lobe* (*l. hepatis dexter*, s. *major*) is about four times as large as the *left* (*l. hepatis sinister*, s. *minor*), and much exceeds it in all its dimensions, but particularly in its thickness.

Its upper face is uniformly convex; the lower presents elevations and depressions which render it very uneven.

These inequalities are connected with the blood vessels, the lymphatics and the biliary vessels which enter or emerge from the liver, and correspond to the *fissures* (*hilus*) of the other glandular organs.

The two edges of the liver, the *anterior* or *inferior*, and the *posterior* or *superior*, are generally convex, but the first is more so than the other. The anterior is thin and sharp, the posterior thick and blunt, so that the upper and lower faces gradually unite in that part, although there is a very distinct limit between them.

The left portion of the lower face of the right lobe, which is the smallest, and which occupies the centre of the lower face of the liver, considered as a whole, has the form of an H inclined from before backward, the transverse bar and the two legs of which are formed by the *fissures* (*sulci*, s. *foveæ*) which converge behind the lower face of the liver, between which are the *elevations* (*lobuli*).

§ 2207. The *transverse* or *median fissure* (*sulcus intermedius*, s. *transversus*) is situated about the centre, a little nearer the posterior than the anterior edge. We notice in it the commencement of the

excretory duct of the liver, or the *hepatic canal* (*d. hepaticus*), the commencement of the arterial portion of the vena-porta and the hepatic arteries. The hepatic canal is situated entirely forward, the vena-portæ between an anterior and a posterior series of branches of the hepatic artery. Each of these three vessels divides into a right and a left branch; from the hepatic artery are commonly formed two, which are entirely distinct, a right and a left.

§ 2208. The *left longitudinal fissure* (*fossa longitudinalis sinistra*), which separates the right from the left lobe, extends from the anterior to the posterior edge. The left extremity of the vena-portæ divides these into two halves, an anterior, longer and deeper, and a posterior, smaller and more superficial.

The anterior half (*fovea pro vena umbilicali*, s. *lig. teretc*) is the groove for the umbilical vein or the round ligament of the liver.

Gunz has asserted, contrary to most anatomists, that this anterior half is most generally changed into a real canal, as in almost all animals, by one or more bands of the substance of the liver, which extend like a bridge from the lower face of the great lobe to that of the small, and are sometimes also replaced by a simple prolongation of the peritoneal capsule of the gland.

The posterior half of the left longitudinal fissure, which is more superficial than the anterior, especially toward the left lobe, is the fossa for the venous canal (*fossa pro ductu venoso*), which is there directed from before backward, from below upward, and near its termination a little from left to right.

It is continuous posteriorly with the fissure of the ascending vena-cava.

We rarely find it intimately united with the venous canal by a layer of the substance of the liver, which is then very thin.

§ 2209. The *right longitudinal fissure* (*fossa longitudinalis dextra*) is much more superficial, and its anterior part, separated from the posterior by the vena-porta, differs much from this latter in form and in importance.

The anterior is planer and is not covered by the peritoneum; it receives the gall-bladder (*fossa pro vesiculâ felleâ*). This depression is most generally indicated forward by a greater or a less groove, and sometimes it communicates near its anterior extremity with the upper face of the liver by an opening.

The posterior is directed from below upward, and is continuous with the posterior edge; it is termed the *fossa of the vena-cava* (*fossa venæ cavæ*), because it receives the upper part of the ascending vena-cava. It blends posteriorly in the blunt edge of the liver with the fissure of the venous canal. It is rarely wholly or partially changed into a canal by a band of the substance of the liver.

About twenty small hepatic veins proceed from this fossa from below upward, in pairs side by side, and empty into the ascending vena-cava; but from its upper part arise two large venous trunks, a right and a left, which terminate in the same manner.

Thus the vena-cava follows, in the arrangement of its branches, the same law as the other vessels of the liver, and although the latter is a simple organ, it seems composed of two halves, a right and a left.

Its vascular fissures are separated from each other on the lower face by the posterior middle lobe; they however blend together posteriorly.

§ 2210. The portion of the lower face of the liver, situated between the two longitudinal fissures, is divided by the portal eminence into two halves, an anterior and a posterior.

The anterior, which is deeper, is situated between the depressions of the gall-bladder and the umbilical vein on one side, and the portal eminence and the anterior edge on the other, and has been called from its form the *square lobe* (*l. quadratus*).

The posterior is smaller, more elongated, narrower, but more prominent, because situated on a narrower base, is found between the porta, the fissure of the ascending vena-cava, that of the venous canal, and the posterior edge. It is termed the *lobe of Spigel* (*lobulus Spigelii*, s. *caudatus*).

§ 2211. The right portion of the lower face of the great lobe is the most extensive and thickest, and is uniformly convex or concave.

§ 2212. The left lobe, which is much smaller and thinner, gradually terminates in a blunt extremity. Its upper and its lower faces are smooth and united.

Beside the fissures we have described, we not unfrequently find, particularly in the right lobe, several which vary in size and are not constant; these are analogous to the division of the liver into many lobes in the mammalia.

D. ATTACHMENTS.

§ 2213. The liver is enveloped by the peritoneum, except the right part of its posterior edge and the portion of its lower face covered by the gall-bladder. This membrane is reflected on it backward by its blunt edge, and forward by the portal eminence or the suspensory ligament. There is no other envelop between it and the tissue of the gland in most of its extent; we however find an intermediate layer of cellular tissue at the posterior part of the upper face near the edge.

§ 2214. The liver is kept in place by several folds of peritoneum, namely:

1st. By the *coronary* ligament, at its posterior edge.

2d. By the *right* and *left triangular* ligaments, which form its right and left extremities, to the lower face of the diaphragm.

3d. By the *suspensory* ligament, which is attached to the lower face of the diaphragm and to the linea alba.

The small epiploon unites it to the small curve of the stomach.

A short cellular tissue also unites it very loosely to the right kidney, which it receives in a depression of the lower face of its right lobe.

E. COLOR, SPECIFIC GRAVITY, AND CONSISTENCE.

§ 2215. The color of the liver is brownish red in young persons and those in the prime of life. It becomes darkish and blacker in old age. Its specific gravity is about as 15 : 10.

Its substance is firm, but brittle. Thus the liver is one of the organs most frequently ruptured, from a mechanical cause acting on the parietes of the abdomen when the external parts are uninjured.

F. TEXTURE.

§ 2216. The parenchyma of the liver is not absolutely homogeneous. In fact we do not find, as in the other glands and the encephalon, the two substances of which it is composed separated from each, so that one is placed internally and the other externally. But whatever point we examine, these two substances, which are every where arranged alternately, are easily distinguished. At first view they seem to form undulated bands about half a line thick ; but when examined more attentively we perceive that the yellow forms a coherent mass in all parts of the gland, that it there produces numerous elevations and depressions, although interrupted in many parts, and consequently represents a very complicated net-work. In the spaces, which are about a line in diameter, and which are polygons, we find a dark substance which does not form a coherent whole like the preceding, and which is softer but less transparent than it.

Ferrein had already well distinguished these two substances.(1) Haller(2) and Gunz(3) also mention its discovery. Autenrieth,(4) Bichat,(5) Cloquet,(6) and Mappes,(7) have also mentioned this structure, which we have always thought was easily seen ; hence we consider as erroneous the opinion(8) that they are arranged arbitrarily. Physiologists, however, differ in regard to their uses. Ferrein terms the deep colored substance the *medullary*, and the bright colored substance the *cortical ;* while Autenrieth and Mappes have applied these terms in opposite senses. The views of these last two writers seem to us to be more just than those of the others regarding the difference in the consistence and the transparency of the two substances, in respect to their color, or finally their arrangement in regard to continuity, since in all these respects the bright substance is more similar

(1) *Mém. de Paris*, 1735, hist. 51.
(2) *Bibl. anat.*, vol. ii., p. 253.
(3) *De hepate*, p. 28.
(4) *Ueber die Rindensubstanz der Leber ;* in Reil, *Archiv. für die Physiologie*, vol. vii., 1817, p. 299–308.
(5) *Anat. descript.*, vol. v., p. 93.
(6) *Traité d'anat.*, vol. ii., p. 1032, 1033.
(7) *Loc. cit.*, p. 6.
(8) Portal, *Anat. prat.*, 1804, vol. v., p. 278.

to the bright substance of the encephalon, the spinal marrow, and the kidneys; and the dark substance to the cortical substance of these latter.

When the yellow medullary substance is examined attentively, it seems formed of small points or grains.

We may term the small masses composed of medullary and of cortical substance the *lobules* (*acini*), although they are more blended than in the other glands, and are not separated by spaces filled only with cellular tissue; so that the structure of the liver is consequently much less lobular than that of the salivary glands.

From the consistence and hardness of the substance of the liver, the orifices of the vessels which are intimately united with it remain gaping when it is cut.

§ 2217. The liver is formed by the ramifications of the biliary ducts, of the vena-portæ, of the hepatic artery and the hepatic veins, and by lymphatic vessels and nerves, united by mucous tissue. It is, however, essentially formed by the biliary vessels and the mucous tissue which surrounds them.

§ 2218. The vessels of the liver are not all distributed exactly in the same manner. They vary in their connections with each other, and with the substance of the organ.

The hepatic artery, the vena-portæ, and the biliary ducts are enveloped in their whole course through the substance of the liver by a common cellular sheath, a prolongation of the capsule of Glisson. Hence they are not in direct contact with the substance of the gland, like the ramifications of the hepatic artery, around which the capsule does not exist, and they are more solid and more resisting than the latter.

The hepatic artery seems to be intended for the nourishment principally of the tissue of the liver; for according to Glisson's observations,(1) which have since been proved correct by Bianchi,(2) Walter,(3) and Mappes,(4) it is distributed on the other vessels, giving rise there to a very complex net-work. The finest ramifications, however, enter the vena-portæ.(5)

Its branches are fewer and straighter than those of the latter.(6) When injected it is generally entirely filled, but sometimes this is true only of the vena-portæ.(7)

§ 2219. The vena-portæ forms by far the largest part of the vascular substance of the liver. It ramifies very frequently, and evidently

(1) L. i., c. xxix., *De arteriæ hepatis distributione.*
(2) *Loc. cit.*, pt. i., cap. viii., § 5.
(3) *Loc. cit.*, p. 96.
(4) *Loc. cit.*, p. 13.
(5) Walter, p. 96, 99.
(6) Id., p. 95, 96.
(7) Id., p. 68.

like a disk, although one of the two branches is much larger than the other.(1)

It terminates in two modes ; several branches, some of which are very large and even a line in diameter, anastomose with the corresponding twigs of the hepatic veins,(2) and hence the facility with which the vena-portæ is injected through these latter, or the hepatic veins through the vena-portæ.(3) Other and more minute branches are more particularly connected with the origins of the biliary ducts ; but their connections are less intimate than those we have mentioned, since by injecting the vena-portæ we can never fill the biliary canals alone, but the injection always passes into the other vessels, particularly into the hepatic veins.(4) Its most minute twigs do not enter into the medullary substance of the liver, but are distributed in the cortical substance, and have no direct or proximate connection with the first.(5)

§ 2220. The biliary canals differ from the other vessels of the liver, as their twigs are larger. Only the large branches unite in the manner of a disk. The union of the small twigs is less regular, and several proceed from the same point. Their parietes are much firmer than those of the veins. The muciparous depressions upon their inner face on the outer half of the liver do not exist except in the largest branches, and entirely disappear in the most minute, which are perfectly smooth. When they are injected the injection generally penetrates into no other kind of vessel, or when this happens the lymphaties,(6) and next the branches of the vena-portæ are most perfectly and frequently filled.

The roots of the biliary canals seem to arise on the limit between the medullary and the cortical substance, although they do not distinctly pass through the former.(7) They never terminate on the surface of the liver, and even when they are superficial, they penetrate within the gland.

2221. The twigs of the hepatic vein are also fewer and larger than those of the vena-portæ and the hepatic artery. They do not contribute as much as the vena-portæ, to form the substance of the liver,(8) although their less degree of development is only apparent, since their twigs are so small, that they are more easily destroyed than the other hepatic vessels. When injected, the fluid scarcely passes, excepting into the vena-portæ.(9) Their direction is generally transverse, while that of the other hepatic vessels is oblique from below upward, and almost perpendicular, so that they cross these latter. Their final twigs

(1) Mappes, p. 13.
(2) Bertin, in the *Mém. de Paris*, 1765.—Walter, p. 94, 95.
(3) Walter, p. 63.—Mappes, p. 23.
(4) Id., p. 64, 65.—Mappes, p. 22.
(5) Mappes, p. 11-13.
(6) Walter, p. 70.—Mappes, p. 24.
(7) Mappes, p. i.
(8) Walter, *loc. cit.*
(9) Glisson, p. 285.

are more intimately connected with their medullary substance than those of the other hepatic vessels, and it is more or less easy to trace them into this substance, which depends partly on their not being surrounded like these latter by the cellular capsule.

§ 2222. The lymphatics of the liver are intimately connected with the biliary ducts, and their cavity directly communicates with them, or at least the substance between them is extremely thin, soft, and easily destroyed. Those of the different regions of the liver do not anastomose together, for the injection of one branch fills only the portion of the organ to which this branch is distributed.

B. EXCRETORY PORTION OF THE BILIARY SYSTEM.

§ 2223. The excretory portion of the biliary system includes the proper *excretory duct* of the liver, and a cul-de-sac of this canal termed the *gall-bladder* (*cystis*, s. *vesicula fellea*, *cholecystis*).

A. EXCRETORY DUCT.

§ 2224. The *excretory duct*, of which we have already described the portion within the liver, is formed by two membranes, one external, solid, and cellular, the other internal, thicker, and smooth presenting numerous and very compact depressions. We distinguish in it three portions, the *hepatic* canal, the *cystic* canal, and the *ductus choledochus*.

The *hepatic* canal (*d. hepaticus*), or the first portion of the excretory duct, arises in the fissure of the vena-portæ generally by two branches, one on the right, which is smaller, and comes from the anterior part of the great lobe of the liver, the other on the left, which is larger, and arises from the posterior part of this lobe, and from the left lobe. These two branches anastomose at an acute angle before leaving the fissure of the vena-portæ. The canal formed by their union is from one and a half to two inches long, and nearly two lines broad in the normal state; it is directed from above downward, and from right to left, and divides to give rise to the cystic canal and the ductus choledochus, which make a part of it.

The *cystic canal* (*d. cysticus*) is directed at an acute angle forward, downward, and to the right. It is narrower, and usually a little longer than the hepatic, and enlarges to form the gall-bladder.

B. GALL-BLADDER.

§ 2225. The *gall-bladder* is situated in a special depression of the lower face of the liver. It is usually pear-shaped. The extremity, near its orifice, termed the *neck* (*cervix*), is the narrowest part; it is broadest in its centre. Its anterior extremity terminates in a cul-de-sac, and is called the *base* (*fundus*); it commonly extends a little beyond the anterior edge of the liver. The gall-bladder generally adheres in-

timately by its upper part, to the lower face of the liver, but sometimes also it is loosely united with it by a fold of the peritoneum. The peritoneum covers it more or less perfectly, according as it presents one or the other of these two arrangements.

We find below the peritoneum a dense cellular tissue, in which proceed the large vascular trunks, and which is called the vascular or nervous tunic. The external face of the second tunic presents some fibres which are generally whitish, proceed in different directions, sometimes very analogous to those of the muscular coat of the intestinal canal, and which cannot be considered as forming a distinct layer.

The cellular tunic covers the internal or mucous membrane, the inner face of which presents folds which represent a reticular tissue, formed of irregular pentagons, which do not disappear even when the gall bladder is in its greatest possible state of distension. Some very small openings, which are observed on this face, lead to simple glands which are commonly invisible. Only ramifications of veins are distributed on the surface of the folds.

The cystic canal and the neck of the gall-bladder are contracted by about a dozen transverse folds, which are real valves, and arise from the internal and cellular tunics. Most of these folds have their loose edge turned toward the cavity of the gall-bladder, so as to form between them and the wall of the canal, a depression which has the same direction.

These folds gradually enlarge from the hepatic canal toward the neck of the gall-bladder. They are attached to each other, especially the largest, by intermediate, longitudinal, oblique, elevations which are less prominent.

§ 2226. The *ductus choledochus*, or the lower portion of the excretory canal of the liver, is the continuation of the hepatic and the cystic ducts. It is a little broader than these two canals, but it is more similar to the hepatic in structure and diameter, and may be considered the direct continuation of it, for it has the same direction, and there exists, at least very frequently, along the opening of the cystic canal, a small elevation between it and these two passages.

This canal is generally about four inches long; its lower extremity goes to the posterior wall of the duodenum, and opens at its central portion. Its diameter is generally the same until it opens into the intestine, but it contracts much in gliding between the muscular and cellular tunics of the latter, and finally terminates in an orifice which is narrower than the rest of its course.

§ 2227. When we cut the duodenum, we observe in the posterior wall, the opening of the ductus choledochus, in the form of an oblong tubercle, about four lines in length, and presenting at its lower extremity an opening directed obliquely from above downward; this opening is generally situated three inches below the commencement of the intestine, and is formed by the mucous and cellular membranes of the latter and the ductus choledochus, which are uninterruptedly continuous with each other.

The lower part of this orifice does not belong to the ductus choledochus alone, but it is common to the pancreatic canal.

§ 2228. The most evident function of the liver, is the very important one to secrete bile, a green, very bitter alkaline liquid, which is indispensibly necessary to digestion; its physical qualities vary much in more than one respect. The bile is generally distinguished into *cystic* and *hepatic;* the first is thicker, darker, more bitter, and consequently more concentrated than the second; which differences depend on the gall-bladder, and not on the different origin of these two fluids, although Malpighi(1) and Galeati(2) have adopted this last opinion, or at least in part.

It is very probable, that putting out of view this difference of concentration, the bile has not always the same chemical composition.

It always contains a considerable quantity, and generally about eleven-twelfths of water. The rest is composed, according to Thenard, of albumen and of resin, of each about an equal quantity, which form almost the whole of it; a small quantity of insoluble yellow substance, of a still smaller quantity of soluble substance, finally, some traces of soda, of the phosphate, the sulphate, and the hydrochlorate of soda; of the phosphate of lime, and of the oxide of iron, all of which are dissolved in the water except the yellow substance, which is insoluble.(3) The resin admitted by Thenard and his successors, is produced, according to Berzelius,(4) by the action of acids on a peculiar substance, similar to albumen. This chemist considers bile composed in 1000 parts: of water 907.4; of a peculiar substance 80.0; of mucus 3.00; of soda and common salts 9.6. None of these constituent parts contain azote; this is curious, on account of the frequent change of bile into a fatty body, and on account of the analogy of the meconium with vegetable substances.

Thenard asserts that picromel, a peculiar substance of a sweet and bitter taste, which commonly occurs in the bile of most mammalia, does not exist in that of man, but it has been found there by Chevalier.(5)

Probably the bile is formed entirely, or in great part, at the expense of the venous blood of the vena-portæ, and the hepatic artery only serves to nourish the liver.

The principal arguments in favor of this opinion, are:

1st. The distribution of the hepatic artery in the vascular membranes.

2d. The existence even of the system of the vena-portæ.

3d. The great analogy between the venous blood and the bile, and between it and the arterial blood.

(1) *De liene*, c. vi.
(2) *Com. Bonon.*, vol. i. ib. vol. ii. p. i.
(3) *Mém. de la soc. d'Arcueil*, vol. i.
(4) *Med. chir. trans.*, vol. iii.
(5) *Annales de chimie et de physique*, vol. ix.

4th. The relation between the caliber of the hepatic vein and the size of the liver, without regard to the abundance of the biliary secretion, while this latter circumstance is always attended with a greater development of the vena-portæ.

The arguments adduced against this theory, are:

1st. The absence of the system of the vena-portæ in the invertebral animals.

2d. The cases where the vena-portæ opens into the vena-cava, and the hepatic artery is unusually large.

3d. The correspondence between the caliber of the excretory duct of the liver and that of the hepatic artery, and the disproportion between that of the hepatic canal and that of the vena-portæ.

These arguments do not refute those on the other side. We have reasons for thinking that the arterial blood of the invertebral animals is perhaps more proper for the secretion of bile than that of the vertebrated animals. Possibly, also, the arterial blood of the latter was more appropriate for this use in the anomaly on which the second argument rests, than generally, because the biliary secretion then did not contribute to render the blood of the vena-portæ more analogous to that which circulates in the arteries. Farther, all the known cases of this anomaly have been observed in children, the bile being less bitter and less in quantity than usual. As to the third objection, the hepatic artery compared with the arteries of the other secretory organs, seems too small to admit that it serves for secretion and nutrition.

Some physiologists, regarding the size of the liver, its constant existence, and the frequency of its diseases, have been led to believe that it fulfills in the economy another function from that of secreting bile; but this other function is not proved. The uses of the bile are not confined to digestion, but it is connected with the whole vital action; in this respect, the secretion which forms it, prevents an excess of hydrogen and carbon in the body, as is indicated by its increase when the respiratory function diminishes in the animal series, when it does not exist as in the fetus, or when it is deranged as in certain diseases.(1)

The purpose of the circulation of the vena-portæ, however, may also be to attenuate, to assimilate foreign substances brought by the venous system into the intestinal canal, and thus diminish the injurious influence they might exercise on the body.

C. DIFFERENCES DEPENDING ON DEVELOPMENT.

2229. The differences depending on the development of the liver(2) relate to its volume, situation, form, and texture.

1st. The liver is very large during the first week of gestation, and we may say from the first moment of its appearance, that it is propor-

(1) Meckel, *Abhandlungen*, 1806.

(2) Walter, *loc. cit.*, sect. i.—A. Portal, *Observations sur la situation des viscères du bas-ventre chez les enfans, et sur le déplacement qu'ils éprouvent dans un âge plus*

tionally much larger the younger the fetus is. Thus, in the fetus of three weeks, its weight is one half that of the rest of the body,(1) and even in the full grown fetus it is to the latter as 1 : 18, or as 1 : 20, while the relation is as 1 : 35–36 in the adult. But the great proportional size of the liver diminishes at the end of the first half of gestation, because, after this period, the gland increases more slowly. It, however, continues to grow till birth ; but afterward the absolute weight and size diminish until the end of the first year, for we have found in five new born children, that the liver was one quarter heavier than in five other children from eight to ten months old.

2d. The liver at first occupies a much greater space the younger the fetus is ; even at the third or fourth month of gestation, it nearly fills the cavity of the abdomen, descends to the crest of the ileum, and covers the other viscera. This difference, however, partly depends upon its being situated more perpendicularly at first, so that then, that face which is afterwards superior, looks forward, and that which is to be inferior, backward.

3d. Its formation is at first as much more symmetrical as is its situation, and its left lobe differs less in size from the right lobe, and the limit between these two parts corresponds more to the median line. The absolute diminution mentioned above, takes place almost entirely at the expense of the left lobe, for while during this period, the right lobe preserves the size it had at birth, and often even increases a little; the left diminishes in every direction, so that in a child of a year old, it is hardly half as large as in a new born child ; the lobe of Spigel, on the contrary, is more developed. The liver is at first more rounded, and its lower face is more convex than it is afterwards.

4th. Its tissue is softer, more homogeneous, more brittle, and more vascular in the earlier periods of life than subsequently, where the vessels diminish in size, and many of them disappear. We, however, very readily distinguish the two substances in the full grown fetus.

5th. Its color is at first a bright grayish brown ; it does not become a deep red until after the first half of gestation ; its tint brightens shortly after birth, and its tissue then changes also a little in appearance.

§ 2230. The gall-bladder is at first entirely concealed in the substance of the liver, is proportionally very long, narrow, filiform, a little enlarged at its lower extremity, and empty. Its cavity cannot be seen except by the aid of the microscope. Its inner membrane is smooth until the sixth month of gestation ; broad, irregular elevations are then developed in it, between which are narrow depressions, similar to superficial grooves. These grooves gradually become deeper, and also more numerous, and many fissures are developed on the surface

avance ; in the *Mémoires de Paris*, 1771.—Id., *Observations sur la situation du foie dans l'etat naturel, avec des remarques sur la manière de connaitre, par le tact, plusieurs de ses maladies ;* in the *Mém. de Paris*, 1773.—J. S. Schumann, *De hepatis in embryone magnitudinis causis ejusdemque functione cum in fœtu tum in homine nato*, Breslau, 1817.

(1) Walter, *loc. cit.*, p. 45.

of the elevations ; hence, regular and narrow cellules are formed, which are separated by thin intermediate septa.

Notwithstanding its primitive narrowness, the gall-bladder is never deficient at any period, according to our observations, as one would be led to believe from some cases where its total absence has been asserted. Its situation also in regard to the other biliary organs, is always the same ; consequently it never arises by a kind of granulation, developed from the extremity of the biliary passage, but it arises in the groove at the lower part of the liver, which is destined particularly for it, and which is at first proportionally much deeper than in the adult. We have never known it to communicate with the liver at first by one or more special canals, while we have seen it manifestly terminate in a cul-de-sac.

D. ABNORMAL STATE.

§ **2231.** The liver is one of the organs most(1) frequently abnormal in more than one respect, but principally in its texture, which undoubtedly depends on the numerous organic elements which compose it.

A. LIVER.

§ **2232.** The deficiency of the liver has hitherto been observed only in some acephalous monsters ; in these it is the rule, which has but few exceptions, that the liver is always very small.

This organ sometimes preserves the same situation as in the fetus, which depends on the imperfect development of the anterior face of the abdomen. In this case it is sometimes situated externally, forming either alone or with the other viscera, an umbilical hernia, in which it is wholly or but partially contained. It exists more rarely in the cavity of the thorax, on account of the imperfect development of the diaphragm. Sometimes, in these two cases, especially the first, the herniary part, forms a prolongation, which is attached to the peduncle ; this may give rise to the opinion that two livers exist. Sometimes, also, when no similar mechanical cause exists, the liver is divided by more or less deep grooves, into a greater or less number of distinct lobes.

Sometimes an anomaly of the liver exists, similar to the latter in external appearance, but differing much from it in form and origin. It consists in *fractures* of this organ, which are frequent on account of its fragility, even when the external parts are uninjured from external

(1) Portal, *Observations sur la nature et le traitement des maladies de foie*, Paris, 1813.—Farre, *The morbid anatomy of the liver*, London, 1812-1815.—J. Thomas, *A treatise on the diseases of the liver and digestive organs*, London, 1820.—J. Johnston, *A treatise on derangement of the liver*, London, 1820.—J. Faithorn, *Facts and observations on liver complaints and bilious disorders in general*, Philadelphia, 1820.

causes, acting not only on the region of the body in which it is situated, but also upon remote parts.

It is rare that the liver is abnormally small from a primitive deviation of formation, but it often diminishes in the course of time, particularly in advanced life, and finally becomes unusually hard and firm; this state is termed *scirrhus*, although this term is not perfectly convenient.

Hypertrophy(1) of the liver is one of its most common affections; it supervenes at all periods of life, but most frequently in advanced age: it is generally attended with a greater or less alteration of texture, and particularly with *induration*, even when it does not depend solely on new formations within the gland.

Induration of the liver, however, is not always attended by its hypertrophy, although the contrary is generally admitted, since the latter is sometimes attended with softening. Hypertrophy of the liver frequently attends chronic general diseases, especially rachitis, scrofula, and dropsy. In this case the gland is usually harder than in health: but in scrofula, on the contrary, where we find hypertrophy at least as frequently, its tissue is softer than in the normal state. The enlargement of the liver, which usually attends pulmonary affections, is evidently, at least in most cases, an effort of nature to restore health.

Induration of the liver is the most frequent alteration of texture, and it often exists with or without enlargement. Softening of the liver is much more rare, and exists sometimes with, and sometimes without atrophy of the gland.(2)

The new formations in the liver are rarely repetitions of the normal tissues: the most common anomaly is the change into fat, which exists in several different degrees, usually affects the whole organ, and is observed in the idle and luxurious.

Accidental ossification is generally developed on the edge of the liver, below the peritoneal coat. Probably it is only a change of another accidental formation, for instance, of one of those serous or fibroserous cysts, often developed in the liver, where they form hydatids.

The liver is not unfrequently the seat of entirely new formations, generally termed *tubercles* (*tubera*).(3) These tumors are rarely inclosed in a cyst, and are rounded. They are generally whitish, seldom red or brown. They vary in size from three to four inches. They are frequently very numerous, being developed in the centre of the liver, which is otherwise healthy. Like most new formations, they are

(1) V. Murat, *Sur l'hypertrophie du foie;* in the *Bull. de la soc. méd. d'emul.*, September, 1821.

(2) Portal, p. 117.

(3) V. Murat, *Des moyens de distinguer entre elles les diverses affections du foie, désignées sous les noms de tubercules scrofuleux, d'hydatides, de squirrhe, d'hydropisie enkystée, généralement confondues sous le nom d'obstructions;* in the *Bull. de lo soc. méd. d'émul.*, September, 1821.

generally albuminous.(1) Those, however, which have a brownish tint, appear from some recent experiments, to be more analogous with gelatine.(2) The diseases they resemble are principally scrofula or fungous hæmatodes.

All the anomalies in the mass, size, and consistence of the liver hitherto mentioned, all the accidental formations mentioned in this gland, supervene principally after the immoderate use of ardent spirits. As they render the liver unfit for the secretion of bile, or prevent the excretion of that which it forms, they frequently occasion *jaundice*. This affection depends on a deposition of bile in a greater or less number of organs and fluids, particularly in the skin. It may also be determined by the adjacent organs, and sometimes we discover no alteration to which it can be attributed.

From the important functions of the liver, and also the intimate connection between it and the mind, this organ varies more or less in all general chronic and in all mental affections.

Entozoaries are developed in this gland more rarely. The animals most commonly found there are hydatids, which occur in the liver more frequently than in any other organ; they are extraordinarily large and numerous, and form very rapidly; they are generally developed in one point, rarely in several, and most commonly in the right lobe. They are commonly separated from the healthy substance of the organ by cysts, usually formed by several layers. They not unfrequently destroy the liver to a great extent, and quitting the place where they are formed, generally proceed outward, most commonly by entering into the intestinal canal, more rarely into the chest and lungs, sometimes even directly through an opening in the common integuments.

Biliary concretions are more rare in the liver; probably they always form in the biliary passages, whence they afterwards pass into the substance of the gland.

B. BILIARY PASSAGES.

§ 2233. Sometimes, but rarely, a part of the biliary passages, particularly the gall-bladder, is deficient(3) from a primitive deviation of formation, although this anomaly does not necessarily exercise an injurious influence on the health, which is less astonishing, since, according to the experiments of Herlin, the gall-bladder may be extirpated in cats without inconvenience, and it is normally absent in many animals. On the contrary, the entire absence of the biliary passages(4) is always attended with the most fatal results.

(1) Portal, p. 95, *Des obstructions albumineuses du foie.*
(2) Portal, p. 98, *Des obstructions gélatineuses du foie.*
(3) Ollivier, *Note sur l'atrophie de la vésicule biliare;* in the *Archiv. gén. de méd.*, vol. v., p. 196.
(4) Home, *Phil. trans.*, 1813, pt. ii., p. 146–158.

We rarely also meet in the biliary passages deviations of formation in regard to the quality, such as the existence of *hepato-cystic ducts* (*d. hepato-cystici*), going directly from the lower face of the liver into the gall-bladder, the slow union of the two roots of the hepatic canal, the opening of one or more branches into the cystic canal, or even into the gall-bladder, the insertion of the ductus choledochus in a point different from the intestinal canal, or even in the stomach.

Of all the biliary passages, the gall-bladder most frequently presents anomalies of this kind, since when it is divided by a contraction into two cavities, placed successively in a longitudinal direction, or, as is more rare, when a longitudinal septum divides it into two parts adapted one to the other. The enlargement and the contraction of the biliary passages generally depends on mechanical causes, among which we must place first the biliary calculi contained within them, next, as is more rare, the engorgement of the lymphatic glands, which compress it from without inward.(1) The gall-bladder may be contracted or dilated by the calculi within it. The contraction and the total obliteration of its cavity occur when a few or small calculi prevent by their situation the bile from entering it. On the contrary, numerous or large calculi, either alone or together with the bile, often dilate the gall-bladder considerably when they are so situated as not to prevent entirely the entrance or departure of the bile, or when they exist in the ductus choledochus. Sometimes the gall-bladder is enormously distended, simply by an increased secretion of bile, without any mechanical obstruction; the membranes of this latter are then generally thin, while in the opposite state they are very thick. Sometimes the calculi are separated by perfect septa.

New formations rarely occur in the gall-bladder; we must mention as such, however, the osseous plates sometimes developed on the outer face of the mucous membrane, and the hairs inserted on its inner face.

(1) Andral (*Observations sur l'oblitération des canaux biliaires;* in the *Archiv. gên. de mêd.*, vol. vi., p. 16) admits four principal causes of perfect or imperfect, transient or permanent obliteration of the biliary passages; these are the obstruction of their cavity by a foreign body, a compression upon their parietes by membranous folds and by tumors of different kinds, a spasmodic contraction independent of all inflammation, and an inflammation followed by the engorgement of the mucous membrane and its thickening. He remarks that the first two causes are frequent, that in most cases the third has rather been supposed than demonstrated, and that physicians have not yet attended to the fourth. The latter, however, seems to be, if not always, at least very frequently, a consequent of a gastro-intestinal inflammation; it is not unusual, and we have every reason to think that it always exists in the cases where the *nervous* pathology led one to suppose the third. Like all inflammations, that of the biliary passages, whether acute or chronic, is attended with the thickening of the parietes of the canal, which is finally changed into a ligamentous cord. F. T.

C. BILE.

§ 2234. The bile is often abnormal in its physical and chemical qualities, although we cannot always discover a certain connection between its anomalies and the state of the liver. It however seems less bitter when this organ is changed into fat.

The most striking anomaly is that resulting from the presence of biliary calculi.(1)

These concretions, which are found in aged persons, or in those who lead a sedentary life, differ from each other in situation, composition, color, number, size, texture, form, and consistence.

1st. *Situation.* The biliary calculi generally occur in the gall-bladder, so that they seem to be developed in this organ. They have been found also in the biliary passages, in the substance of the liver, although proportionally very rarely. Sometimes also they are situated in the hepatic or cystic canal, or in the ductus choledochus, but they finally fall into the gall-bladder. Not unfrequently they leave the ductus choledochus and pass into the intestinal canal.

The rarest case is where they occur out of the cavity of the biliary passages in the substance of the liver, or in the membranes of the gall-bladder. The former may be formed in the place where they occur; but the second are doubtless primitively developed in the cavity of the gall-bladder, and afterwards glide between its membranes, and are then inclosed by the closing of the opening which at first existed, although it is admitted they are formed in the place even where they are observed; and this fact has even been cited to prove that the bile is partially secreted by the glands of the gall-bladder.(2)

The justice of our etiology is demonstrated by the fact, that calculi are sometimes found in the depressions of the gall-bladder, which case is evidently intermediate between that where they are entirely loose in the cavity, and where they are situated on the outside of it and encircled in the membranes.

2d. *Chemical composition.* The chemical composition of the biliary calculi generally causes all those properties of which we have yet to speak. They are composed principally of two different substances; one more or less dark in color and brownish, and the other white; the latter is termed *cholesterine.* The bile contains none of it in the normal state.(3) The other is the yellow coloring substance of this

(1) Vicq-d'Azyr, in the *Mém. de la soc. de méd.*, 1779.—Fourcroy, *Sur les calculs des animaux;* in the *Annales du Muséum*, vol. i.—S. T. Sœmmerring, *De concrementis biliariis*, Frankfort, 1793.—Mosovius, *Diss. de calculorum animalium origine et naturâ*, Berlin, 1812.

(2) D. G. Galeati, *De calculis in cysti fellcâ et intra ejus tunicas repertis;* in the *Comm. Bonon.*, vol. i., p. 354.—Id., *De cystis felleæ ductibus*, same journal, vol. i., pt. ii., p. 331.

(3) Chevreul has detected it in the bile of man and several animals (*Note sur la présence de la cholestérine dans la bile de l'homme;* in the *Journ. de physiol. expér.*, vol. iv., p. 267). F. T.

fluid. The cholesterine probably arises from the change of a peculiar substance which exists in the bile.

The biliary calculi also contain a little of bile, which is easily separated from it by water.

We rarely find carbonate of lime on their surface.(1)

3d. *Color.* These concretions are more or less colored from the brighest yellow to the deepest dark brown, because they generally contain the substances mentioned above. Those only which are formed of cholesterine are entirely white, and they are very uncommon. Farther, the tint varies in the different parts of a biliary calculus.

4th. *Number.* It varies from one to several hundreds. The calculi formed of pure cholesterine are usually single, or at least very few.

5th. *Volume.* It varies no less than the number, and usually in an inverse ratio. The calculi of pure cholesterine are generally larger than the compound concretions. Not unfrequently one of them fills the gall-bladder, and even distends it.

6th. *Form.* The biliary calculi are generally more or less round; those of pure cholesterine are more oblong. Their form is modified also by their number, since the friction between them renders their surface smooth. Hence why those of cholesterine are generally more corrugated than the others; but these concretions rarely present sharp points.

7th. Their *texture* varies.

a. The biliary calculi are generally full and solid; we, however, have one which is hollow.

b. They are formed of several superimposed and differently colored layers.

c. These layers are sometimes, though rarely, composed of one of the two substances mentioned above. In the contrary case they are all colored, and differ only in their shade of color. We not unfrequently find externally an entirely white layer.

d. The light colored layers have generally more or less evidently a radiated and fibrous texture. It is often easy to see that they are formed of very oblong pyramids slightly connected with each other, the summits of which converge towards the centre. This form seems to depend on the cholesterine, for it is never more apparent than in the calculi formed by this fatty body, and it decreases inversely with the color.

e. Consistence. Biliary calculi generally are neither very hard nor solid. They are much softer and more brittle than the urinary concretions. Sometimes, however, they are considerably hard. Those of pure cholesterine are generally harder than the others, being even very firm and solid; but they are frequently also very soft, while others which are more deeply colored are considerably hard.

(1) *London med. repository*, vol. iv., p. 469.

II. PANCREAS.

§ 2235. The *pancreas*(1) is the largest of the salivary glands. Its weight and size are three or four times those of the parotid gland, as it is six inches long and one thick, and weighs from four to six ounces. It is oblong, and is situated transversely at the upper part of the abdominal cavity, before its posterior wall, in front of the first and second dorsal vertebra, behind the stomach. Its left extremity generally touches the spleen and the left kidney. It passes before the aorta, and its right extremity is situated between the upper and lower folds of the duodenum.

It is included between the two layers of the transverse mesocolon, which slightly adheres to its upper part, and does not cover it posteriorly.

Its figure is that of a hammer, since it enlarges at its right extremity, from whence proceeds an inferior prolongation, which embraces the duodenum posteriorly, and on the left, and even a little forward. The lower prolongation is called the *head*, and the transverse larger portion the *tail*.

§ 2236. The pancreas is attached to the adjacent parts by a very loose cellular tissue, and enveloped by a thick layer of the same; it has no special capsule. We also distinguish through the cellular envelop, the lobes which unite to form it.

These lobes can be divided into extremely minute lobules, attached by a very loose cellular tissue.

The pancreas is yellowish brown, and rather firm in its texture.

§ 2237. A considerable excretory duct passes entirely through this organ; it is white and solid, and is called the *pancreatic canal* (*ductus pancreaticus*),(1) or the *canal of Wirsung* (*ductus Wirsungianus*). This canal arises at its posterior extremity by the union of several branches, which anastomose at an acute angle. In its course it receives at a right angle, both above and below, a considerable number of other branches, which may be easily followed by smaller granulations, so that it gradually increases in volume, and finally becomes a line and a half in diameter. Just before quitting the gland, it also receives one or more very large twigs, which arise from the head, and which also open separately into the duodenum.

This canal is not visible on the surface of the gland, which must be cut across in order to see it.

(1) Brunner, *Exp. nova circa pancreas*, Amsterdam, 1638.—Graaf, *De succo pancreatico*, Leyden, 1664.—Johrenius, *De affect. hypochondriacis*, Rinteln, 1678.—J. M. Hoffmann, *De pancreate*, Altdorf, 1706.—J. D. Santorini, *Tabulæ septemdecim*, tab. xiii.

(2) J. G. Wirsung, *Figura ductus cujusdam, cum multiplicibus suis ramulis noviter in pancreate, in diversis corporibus humanis observati*, Padua, 1643.

It generally opens into the duodenum, three or four inches below the pylorus, but sometimes much lower down, and even ten inches from it.

In the place where it communicates with the duodenum, it unites externally with the ductus choledochus, but the two cavities remain perfectly distinct, even when proceeding side by side through the membranes of the intestine. They open side by side near the pancreatic duct, a little to the left of the choledochus, at the base of a small cavity about two lines long, the membrane of which has all the characters of the inner tunic of the duodenum, so that we cannot properly consider them as having a common orifice.

Near its orifice the excretory duct of the pancreas enlarges more or less, but contracts at its opening, although there is no fold similar to a valve in this or in any other part. The appearance of a valve at its opening depends only on the septum between it and that of the ductus choledochus.

§ 2238. The pancreas, like all the salivary glands, and most of the glandular organs, is more developed in the early periods of life than subsequently.

We have observed that its excretory duct very constantly presents a remarkable difference, as it is at first double, that is, beside the permanent valve, there is then a second, which opens separately into the duodenum.(1)

§ 2239. The congenital anomalies of this gland extend principally to the arrangement of its excretory duct, which sometimes seems double; this state must be considered as a permanence of that in the fetus.(2)

The most remarkable consecutive anomalies are *induration* and *hypertrophy*. We more rarely find in its excretory duct, calculi,(3) composed of phosphate of lime and of an animal substance.

III. SPLEEN.

A. PERFECT STATE.

§ 2240. The *spleen* (*splen*, *lien*)(4) is situated in the left hypochondrium, between the great cul-de-sac of the stomach, the lumbar portion

(1) Meckel, *Abhandlungen*, p. 331, 353, 366, 380.

(2) Tiedemann, *Sur les différences que le canal excreteur du pancreas presente dans l'homme et dans les mammifères;* in the *Journ. compl. des sc. méd.*, vol. iv. p. 370.

(3) Baillie has figured a remarkable case of it. (*Engravings*, fasc. v. tab. vii.)

(4) F. Schuyl, *De naturâ et usu lienis*, Leyden, 1664.—Malpighi, *De liene;* in *De structura viscerum*.—C. Drelincourt, *De lienosis*, Leyden, 1693.—G. Stukeley, *The spleen, its description, uses, and diseases*, London, 1723.—J. G. Duvernoi, *De liene*; in the *Comm. Petrop.*, vol. vi. p. 156.—S. T. Quellmalz, *De liene*, Leipsic, 1748.—C. L. Rolof, *De fabrica et functione lienis*, Frankfort, 1750.—Lassone, *Histoire anatomique de la rate;* in the *Mém. de Paris*, 1754.—Werlhof, *De splenis usu*, Wolfenbuttel, 1761.—J. F. Lobstein, *De liene*, Strasburg, 1774.—J. P. P. Assolant, *Recherches sur*

of the diaphragm, the commencement of the descending colon, and the left renal capsule, which it covers anteriorly. Its form is elliptical; its posterior or external face is convex; the anterior or internal is concave, and divided by a longitudinal groove called the *fissure of the spleen* (*hylus lienalis*), into two halves, an anterior, which is the larger, and a posterior. Its upper extremity is a little thicker than the lower; a fold of the peritoneum unites it to the diaphragm, the stomach, and the descending colon.

It varies much in size, not only in different individuals, but also in the same individual at different periods, and inconstantly. In general we may say, that in the adult it is about four inches long, three broad, and a little less than one thick.

Its weight varies as much as its size. Its mean weight is eight ounces, so that in the adult it is to that of the whole body as 1 : 210. But the volume and the weight of this organ are not necessarily in an inverse ratio with the distension of the stomach, as has been asserted.(1) Its specific gravity, compared with that of distilled water, is as 1.200 : 1000.

It is of a brighter or darker red.

The consistence of the spleen is slight; it is also very soft.

§ 2241. At first view the spleen seems formed entirely of blood-vessels, of which the arteries come from the cœliac trunk and the veins rest directly on the surface of the artery, and are proportionally larger than in any other part of the body; they empty into the vena-portæ, and carry there a very dark blood. The substance of the organ is surrounded by a very firm sero-fibrous membrane. The external layer is serous and comes from the peritoneum, with which it is continuous by two prolongations mentioned above.

The fibrous layer belongs properly to the spleen, but it can be separated from the serous membrane only to a slight extent in the fissure.

Numerous layers and very minute solid fibres proceed from it, which interlace in many different ways, and enter the space circumscribed by the capsule, leaving between them irregular spaces, in which the splenic vessels are distributed.

These productions form, properly speaking, the base of the tissue of the spleen.

Beside these fibres, other hollow canals proceed from the inner membrane of the spleen to its fissure; these closely envelop the vessels, and unite with them. The first filaments are attached to the outer

la rate, Paris, 1801.—A. Moreschi, *Sul vero e primario usu della milza*, Milan, 1803.—E. Home, *On the structure and use of the spleen*; in the *Phil. trans.*, 1808.—C. F. Heusinger, *Ueber den Bau und Verrichtung der Milz*, Thionville, 1817.—F. Gellhaus, *Inaugural Abhandlung über den Nutzent der Milz*, Wurzburg, 1817.—G. M. Felici, *Osservazioni fisiologiche sopra le funzioni della milza*, Milan, 1818.—I. Dœllinger, *Betrachtungen uber die Milz*; in the *Deutsches Archiv für die Physiologie*, vol. vi. p. 155.—Jæckel, *Etwas uber die Verrichtung der Milz*; same journal, vol. vi. p. 581.—Hodgkin, *Sur les fonctions de la rate*; in the *Journ. compl. des sc. méd.*, vol. xiv. p. 89.—Home, in the *Phil. trans.*, 1821, p. 25.

(1) Assolant, *loc. cit.*, p. 129–133.

face of these canals in the same manner as to the inner face of the fibrous capsule.

The splenic arteries give off in their course numerous branches, which divide into very minute ramuscules, arranged like the bristles of a brush, but they do not anastomose together. On the contrary, the veins which surround these arterial fasciculi, frequently anastomose with each other, and with the adjacent veins. There are, however, no great communications between the arteries or the veins of the different regions of the spleen. Those between the veins and arteries are very large, as may easily be seen by the aid of a microscope, or by the facility with which injections pass from the arteries into the veins.

Besides the blood-vessels, the spleen also possesses numerous lymphatics. Its nerves come from the splenic plexus, and are very small. They are scarcely one twelfth as large as the arteries they surround, and we cannot trace them far within the organ. Beside these constituent parts, which several anatomists assert are the only ones, the spleen also contains, according to the more correct observations of others, particularly Malpighi, Hewson, Dupuytren, Home, Heusinger, and Meckel, very many rounded, whitish, and very probably hollow, or at least very soft corpuscles, which differ much in respect to size and situation; their size varies from one sixth of a line to one line, and they are sometimes near, and sometimes rather distant apart.

These corpuseles are very intimately connected wtth the rest of the tissue of the spleen, and receive many blood-vessels; according to Home's observations, confirmed by those of Heusinger and our own, they swell much in animals when they drink.

Malpighi considers them as glands. Ruysch and several other anatomists have denied their existence, and have asserted, but wrongly, that they are only simple fasciculi of vessels.

Although neither these corpuscles, nor the spleen, have excretory ducts, they very probably contribute much to the changes of the blood in passing through this organ, and assist in forming the gastric juice, but particularly the bile.

The substance of a reddish brown, easily separated by washing and pressure, should be regarded not as a constituent part of the spleen, but as the blood changed by this organ.

The cellules heretofore admitted in the spleen, were very probably produced by the destruction of a part of the vessels, and of the internal fibrous tissue, by injections made with too much force, whence were formed spaces which are afterwards distended by inflation.

§ 2242. As the spleen has no excretory duct, its functions are very obscure, and the more so, as it has frequently been extirpated without producing any constant or very great derangement in any function. Even at present, after so many experiments infinitely varied, after so many observations and reflections, we can only hazard conjectures on this subject. We may, however, conclude from facts hitherto known,

that the spleen is intimately connected with the functions of the liver and stomach, and acts in concert with these two organs.

That it assists in the functions of the liver, is proved by the fact, that all the blood which passes through its tissue, is carried to this organ by the trunk of the vena portæ. Hence, we may conjecture, and very probably, that the blood is changed within it, and rendered more proper for the secretion of bile, which conjecture is not contradicted by chemical experiments, from whence it has been concluded, that the blood of the splenic veins does not differ from that in the other veins. Possibly, also, the spleen contributes mechanically to increase the secretion of bile, since, during abstinence, a greater or less quantity of blood collects there, which is afterwards expelled by the pressure of the stomach when filled with food, and then goes toward the liver. But as the blood is not merely circulated in the spleen, but there undergoes some change, it follows, that the relation is not mechanical only, but also chemical.

The spleen receives less blood at the commencement of digestion, because the stomach, which is then full, prevents the blood from flowing freely into it; but in proportion as the contents of the stomach pass out from it, the blood flows more easily to the spleen, and the function of this latter, in regard to the liver, becomes more active. Probably also the spleen concurs in the accessory function attributed above to the liver, that of neutralizing and assimilating foreign substances introduced into the body. Hence we must consider it as a viscus which performs, in regard to the vascular system, particularly to the liver, the same part as the conglobate glands towards the lymphatic system. It is more analogous to these glands than to the liver, as it has no excretory duct. The liver then appears as an organ composed of a conglomerate and a conglobate gland in the vascular system.

The action of the spleen may also relate to that of the stomach in several different respects:

1st. In a dynamical respect, since the two organs seem to be opposed to each other, and the soft and blackish spleen may be considered, from its substance and the change of the blood which passes through it, as contributing particularly to produce hydrogen, while the stomach is an organ which, from the nature of its secreted fluid, tends particularly to produce oxygen.

2d. In a mechanical respect, as the spleen attracts the blood to it when digestion is not going on, while it receives less when this viscus is full, so that the blood flows in greater quantity toward the latter, that is, precisely at the period when most necessary to the secretion of the gastric juice.

The function of the spleen seems also to be to receive promptly at least a part of the liquids introduced into the stomach, although this function does not belong exclusively to it, since after it has been extirpated the liquids disappear as quickly as before, and the substances contained in this viscus reappear in certain fluids.

B. DIFFERENCES DEPENDING ON DEVELOPMENT.

§ 2243. At first the spleen does not exist. It begins to appear distinctly during the second month of gestation.

It is at first infinitely smaller in proportion to the body, and particularly to the liver, than it is subsequently, although it wrinkles and also wastes in old age.

The whitish corpuscles are proportionally larger and more visible during the latter periods of fetal existence and in infancy than during the successive periods.

All these peculiarities are very important, as they support the eighth law established in our introduction. In fact the spleen does not exist in the mollusca which have a liver; it becomes proportionally smaller and smaller as we descend from the mammalia toward the lower classes of the animal kingdom; and in most mammalia, as also in several other animals, the corpuscles are regularly larger in proportion than in man.

C. ABNORMAL STATE.

§ 2244. Among the anomalies of the spleen we must distinguish particularly some deviations of formation,(1) which deserve to be noticed.

This organ is very rarely deficient from a primitive deviation of formation in a subject where the formation is otherwise normal, while it is generally absent in cases of acephalia vera.

A deviation of formation almost peculiar to the spleen, or at least observed in it more frequently than in any other organ, is its division into several spleens termed *accessory* (*licnculi*, s. *lienes accessorii*). These accessory bodies are always situated on the inner face, and generally toward the lower extremity of the spleen.

They are usually, but not always, rounded, and vary in number from one to twenty-three. The latter number, however, has been observed only once, and we rarely find more than one supernumerary spleen.

The great number of these accessory spleens is usually attended with other deviations of formation. This occurred in a subject who had twenty-three.(2) In another case, where there were seven, all the organs of regetative life were at the same time inverted.(3) In a

(1) C. S. Heusinger, *Mémoire sur les monstruosités de la rate produites par le défaut de développement de ce viscère;* in the *Journ. compl. des sc. méd.*, vol. x., p. 216.

(2) Otto, *Handbuch der pathologischen Anatomie*, p. 302.

(3) Heusinger, *loc. cit.*, p. 62.

third, where there were four, the foramen ovale of the heart was open to some extent.(1)

The accessory spleens vary much in size.

The existence of a great number of fissures which are frequently very deep on the anterior edge of the spleen, particularly toward its lower extremity, or of a more or less distinct transverse fissure, which passes over its whole external face, form a remarkable intermediate degree between this anomaly and the normal state.

Among the accidental deviations of formation, one consists in an enlargement of the spleen, usually attended with induration, which commonly arises from the metastasis of a general disease.(2)

We not unfrequently find the spleen unusually hard withour enlargement or very soft. The latter exists particularly in diseases attended with great debility.

New formations are rarely developed in the spleen. The tubercles sometimes seen in it are probably white corpuscles somewhat enlarged. Perhaps we should consider a special formation a solid uneven yellowish white mass which is frequently developed in the spleen. It, however, seems to be very similar to fungus hæmatodes.

The capsule of the spleen frequently ossifies, particularly in advanced age, to such an extent even that when the osseous substance has acquired a certain thickness in proportion to which the organ always wastes, we are led to think that the spleen itself is changed into bone.

ARTICLE FIFTH.

VESSELS AND NERVES OF THE ABDOMINAL PORTION OF THE DIGESTIVE ORGANS.

§ 2245. The vessels of the most important and the largest part of the digestive organs mostly arise from three trunks, the cœliac, and the superior and inferior mesenteric arteries, which come directly from the abdominal aorta, and anastomose very frequently together. The lower extremity of the rectum also receives some branches from the hypogastric artery.

The veins, if we except those of the lower part of the rectum which empty into the iliac veins, unite and form the vena-portæ, so that all the blood that returns from these organs passes through the liver before going to the heart, and from thence into the lungs.

(1) Baillie, *Phil. trans.*, vol. lxxviii., p. 350.

(2) C. F. Heusinger, *Ueber die Entzündung und Vergrosserung der Milz*, Eisenach, 1820.—S. Grottanelli, *Ad acutæ et ceronicæ splenitidis historiam animadversiones*, Florence, 1821.—C. H. Schmid, *Commentatio de pathologiâ lienis*, Gottingen, 1816.

The nerves come principally from the great sympathetic nerve. Those of the stomach, however, arise chiefly from the pneumo-gastric nerve, and those of the rectum from the sacral pairs.

CHAPTER II.

ORGANS OF VOICE AND RESPIRATION.

§ 2246. In the preceding chapter on the systems we described the digestive organs which belong to vegetative life; these appear earliest in animals, or in the fetuses of animals, perform at first the functions of all the rest, and are the type on which these latter are formed, which are, however, less perfect and much less complex. We now proceed to describe the respiratory organs, in which the nutritious fluid formed in the first is in general perfected.

The vocal apparatus is so connected with the organs of respiration that it occupies the summit of the canal by which these latter communicate with the air by the cavities of the nose and mouth, and it is in fact only a development of the upper extremity of this canal. It is then most convenient to begin with it.

ARTICLE FIRST.

ORGANS OF VOICE.

§ 2247. The *organs of voice*(1) are composed principally of the larynx, in which the voice is formed, although it is modified in different modes when passing through the cavities of the nose and mouth, which are situated before it.

I. LARYNX GENERALLY IN THE PERFECT STATE.

§ 2248. The *larynx* is an oblong, quadrangular cavity, formed of several cartilages, of ligaments which unite them, of muscles which

(1) Galen, *Vocalium instrumentorum dissectio:* in the *Opp. omn.*—Fabricius of Aquapendente, *De visione, voce, et auditu:* Id., *De larynge vocis instrumento:* in the *Opp. omn.*—J. Casserio, *De vocis auditusque organis*, Ferrare, 1600.—D. Santorini, *De larynge:* in the *Obs. anat.*, c. vi.—A. F. Walther, *De larynge et voce*, Leipsic, 1740.—R. A. Vogel, *De larynge humano et vocis formatione*, Erfurt, 1747.—J. G. Runge, *De voce ejusque organis*, Leyden, 1753.—Herissant, *Recherches sur les organes de la voix des quadrupèdes et de celle des oiseaux:* in the *Mém. de Paris*, 1753.—J. M. Busch, *De mechanismo organi vocis hujusque functione*, Groningen, 1770.—Vicq-d'Azyr, *De la structure des organes qui servent à la formation de la voix, considérée dans l'homme et dans les différentes classes d'animaux:* in the *Mém. de Paris*, 1779, p. 178–206.—J. Wolff, *Diss. de organo vocis mammalium*, Berlin, 1812.

move them, and of a mucous membrane which covers them in every part, after which it is continuous upward with the buccal membrane, below with that of the trachea. This cavity gradually contracts a little from above downward. It is situated at the upper and anterior part of the neck, below and behind the lower jaw, between the trachea and the cavities of the nose and mouth, of which it is the direct continuation.

A. CARTILAGES OF THE LARYNX.

§ 2249. There are nine cartilages which form the base of the larynx, three of which are unmated and six exist in pairs. The pairs are situated on the sides; the unmated are divided by the median line into two equal halves, a right and a left.

The unmated cartilages are the largest, and principally form the whole larynx. They are the *thyroid* and *cricoid* cartilages, and the *epiglottis*. The pairs are the *arytenoid*, the *rounded*, or the *tubercles of Santorini*, and the *cuneiform* cartilages.

I. THYROID CARTILAGE.

§ 2250. The *thyroid* cartilage (*C. thyroidea*), the largest of the cartilages of the larynx, forms its upper and anterior part, produces at the upper part of the neck, a prominence called *Adam's apple*. It is an oblong quadrilateral plate, more broad than high, and composed of two lateral halves, which unite forward on the median line, where the angle they form is more acute in the male than in the female. Hence this layer is very convex forward and very concave backward, where it is open.

Its upper edge is very convex; it however presents in its centre a deep groove, so that the cartilage is lower in this place.

Its lower edge is very convex: it is formed on each side of two superficial grooves, separated by a median prominence.

The posterior edges are loose; they extend upward and downward into two elongated horns, which are rounded and turned backward, and which are distinguished into upper and lower. The upper horns are longer and thinner than the lower.

We observe on the outer face of the cartilage at the base of the upper horn a considerable triangular prominence, whence arises an oblique line which descends from behind forward to the lower edge, and which separates the posterior sixth of each half of this external face of the five anterior sixths.

II. CRICOID CARTILAGES.

§ 2251. The *cricoid* cartilage (*C. cricoidea*, s. *annularis*), which forms the lower part and a portion of the posterior part of the larynx, is circular, as its name indicates, and about three times higher posteriorly than anteriorly. It is convex forward, and on the sides are depressions which render the surface corrugated, and on its upper edge is a sharp prominence which inclines outward.

The posterior part is irregularly quadrilateral and broader below than above. Its anterior face is uniformly concave; the posterior is loose and very prominent in the centre, especially below.

We there observe a depression on each side, and it presents a plane articular facet where it unites with the side.

Its upper edge also enlarges on each side into a plane articular facet which is inclined from above downward.

III. ARYTENOID CARTILAGES.

§ 2252. The *arytenoid*, *triangular*, or *pyramidal* cartilages (*C. arytænoideæ*, s. *triquetræ*, s. *pyramidales*) have an elongated triangular form. Their anterior face is convex and uneven, and divided by a transverse prominence into a superior and an inferior depression.

The posterior has about the same extent as the anterior, and is concave. The internal is much smaller than the other two, and is slightly convex.

These two cartilages are fitted by their concave base to the sides of the upper articular facets of the cricoid cartilage (§ 2251).

IV. ROUND CARTILAGES.

§ 2253. On the summit of each arytenoid cartilage is a much smaller, and also triangular cartilage, termed the *tubercle of Santorini*, or the *round or horny* cartilage (*corniculum*, s. *capitulum Santorinianum*),(1) the convex face of which looks forward, and the internal backward. Its lower face is concave, rests on the convex summit of the preceding, and is articulated with it by a loose capsular ligament, some fibrous ligaments of which add to its solidity.

V. CUNEIFORM CARTILAGES.

§ 2254. The *cuneiform* cartilages (*C. cuneiformes*) are slightly curved on themselves. Their bases are turned upward, and their summits downward. They are situated in the centre of the membranous expansion extended between the arytenoid cartilages and the epiglottis.

(1) *Loc. cit.*, p. 97.

VI. EPIGLOTTIS.

§ 2255. The *epiglottis* (*epiglottis*, s. *ligula*), a very soft cartilage, is nearly rhomboidal; its lower part is pointed, and terminates by a superficial groove, and is situated directly above the groove of the upper edge of the thyroid cartilage. Its length exceeds its breadth, and it is much thinner from before backward than in any other direction, except at its centre. It presents numerous openings, through which penetrate small mucipurous glands, which open on these two faces. Its elasticity, and the ligaments to be described, cause it generally to lie perpendicular, and to rise towards the isthmus of the fauces: but the weight of the substances which pass on it, and the action of special muscles, depress it, so that it covers the entrance of the larynx.

The epiglottis prevents the entrance of foreign bodies, especially the food and drink, from the cavity of the nose, and particularly the mouth, into the larynx. Although pathological observations, in regard to the absence of this cartilage,(1) and experiments, where deglutition has not been impeded by removing the epiglottis, when the nerves and muscles of the glottis were preserved, while it was very difficult when these nerves were divided, the epiglottis remaining entire;(2) although all these facts(3) prove that the closing of the glottis also partially contributes to prevent the food from falling into the larynx, it does not follow that the epiglottis does not fulfill the function attributed to it by every physiologist since the time of Aristotle. This function, in regard to which we quote a lively, but perfectly correct remark of Casserio,(4) has been doubted by Magendie, whose opinion has been contested by Mayer, from observations carefully made upon himself.(5)

(1) Targioni Tozzetti, *Prima raccolta di osservazioni*, Florence, 1752.—Magendie, *Précis de physiologie*, vol. ii. p. 63.

(2) Magendie, *Mémoire sur l'usage de l'épiglotte dans la déglutition*, Paris, 1813.

(3) C. T. F. Reichel (*Diss. de usu epiglottidis*, Berlin, 1816) has observed, contrary to Magendie's assertion, that removig the epiglottis always rendered deglutition difficult in those animals where it was removed. On this subject, Rudolphi mentions the case of a man who died of laryngeal phthisis, in whom the epiglottis was destroyed so that but a small portion of its base remained. This man found it very difficult to swallow: he was obliged to mix drinks with his food to form akind of pulp, which was introduced into the stomach with difficulty. G. Sachse relates several cases, which prove that deglutition is always very much impeded in laryngeal phthisis. (*Beiträge zur genauern Kenntniss und Unterscheidung der Kehlkopfs-und Luftröhrenschwindsuchten*, Hanover, 1821). Farther, Rudolphi attributes to the epiglottis another use also: he thinks that this cartilage serves also in those animals who breathe through the nostrils, the mouth being closed, to favor the entrance of the air into the larynx, by presenting a more direct way than through the cavity of the mouth. F. T.

(4) Loc. cit., *De epiglottide*, c. xvii., *Talis structura, tale officium, ut stupidus ille, vecorsque dici mereatur, quem non eorum consideratio, attonitum quasi, in admirationem Dei rapiat.*

(5) *Ueber die Function des Kehldeckels*, in the *Salzburger Zeitung*, 1814, vol. iii. p. 156.

B. LIGAMENTS OF THE LARYNX.

§ 2256. The cartilages of the larynx are united with each other, and with the hyoid bone and trachea, by capsules, fibrous ligaments, and compact cellular tissue.

I. SPECIAL LIGAMENTS.

A. BETWEEN THE THYROID AND CRICOID CARTILAGES.

§ 2257. The thyroid and cricoid cartilages are united by three ligaments, a central or pyramidal, and two lateral.

a. Middle crico-thyroid ligament.

§ 2258. The *middle crico-thyroid* or *pyramidal* ligament (*L. conoideum*, s. *thyreo-cricoideum medium*), is short, fibrous, strong, and triangular. Its base looks downward, and its blunt summit upward. It fills the space between the centre of the lower edge of the thyroid cartilage, and that of the upper edge of the cricoid cartilage.

It prevents the cricoid and thyroid cartilages from separating from each other too far upward and downward.

b. Lateral thyro-cricoid ligament.

§ 2259. The *lateral thyro-cricoid* ligament (*L. thyreo-cricoideum laterale*) is loose, composed of fibres, which are oblique from above downward, and situated between the lower horn of the thyroid cartilage and the lower articular facet of the cricoid.

Its uses are the same as those of the preceding. It serves, however, also to confine the motions of the two cartilages forward and backward.

B. LIGAMENTS BETWEEN THE THYROID CARTILAGES AND HYOID BONE.

a. Middle thyro-hyoid ligament.

§ 2260. The *middle thyro-hyoid* ligament (*L. thyreo-hyoideum medium*) is a broad layer of compact cellular tissue, which descends from the posterior edge of the body of the hyoid bone, to the middle groove of the upper edge of the thyroid cartilage.

b. Lateral thyro-hyoid ligament.

§ 2261. The *lateral thyro-hyoid* ligament (*L. thyreo-hyoideum laterale*) is oblong, rounded, and formed of longitudinal fibres. It extends

from the summit of the upper horn of the thyroid cartilage, to the extremity of the great horn of the hyoid bone. At about its centre, but generally nearer the upper than the lower edge, it contains a small rounded and oblong cartilage, or bone (*C. tritica*), which, in fact, belongs to the class of the cartilages or bones of the tendons.

C. LIGAMENT BETWEEN THE CRICOID AND ARYTENOID CARTILAGES.

§ 2262. Each arytenoid cartilage is united by its lower face to the upper articular facet of the cricoid cartilage, by a loose synovial capsule, strengthened at intervals by ligamentous fibres.

D. LIGAMENT BETWEEN THE ARYTENOID AND ROUND CARTILAGES.

§ 2263. These two cartilages are united by a very loose, and often slightly apparent capsule, on the surface of which pass ligamentous fibres.

E LIGAMENTS OF THE EPIGLOTTIS.

a. Epiglotti-hyoid ligament.

§ 2264. The epiglottis is united to the upper edge of the middle hyoid bone by a compact cellular tissue, termed the *epiglotti-hyoid* ligament (*L. epiglotti-hyoideum*).

b. Thyro-epiglottid ligament.

§ 2265. The *thyro-epiglottid* ligament (*L. thyreo-epiglottideum*) is strong and fibrous. It extends from the lower extremity of the epiglottis to the groove in the upper edge of the thyroid cartilage.

F. LIGAMENTS BETWEEN THE THYROID AND ARYTENOID CARTILAGES.

§ 2266. We find on each side, between the arytenoid and thyroid cartilages, one above the other, two ligaments, directed from behind forward, from above downward, and from without inward, which are situated some lines from each other, and are termed the *thyro-arytenoid* ligaments (*L. thyreo-arytenoidea*).

a. Inferior thyro-arytenoid ligament.

§ 2267. The *inferior thyro-arytenoid* ligament (*L. thyreo-arytenoideum inferius*), is much larger than the upper, and is composed of very distinct fibres. It extends from the upper and prominent end of the anterior edge of the inner face of the arytenoid cartilage, to the lower

part of the posterior face of the thyroid cartilage, and is attached in this place, directly at the side of its mate, above the groove of the lower edge.

These two ligaments are generally more developed in the male than in the female, and are termed the *vocal cords*, or *ligaments of the glottis* (*L. vocalia*, s. *glottidis*), and the fissure between them is termed the *glottis* (*glottis*, s. *rima glottidis*).

b. Superior thyro-arytenoid ligaments.

§ 2268. The *superior thyro-arytenoid* ligaments (*L. thyreo-arytenoideora superiorum*, s. *ventricula laryngis*) are situated farther outward and upward, between the centre of the anterior face of the arytenoid cartilage, and the angle of the thyroid cartilage. Those of the two sides are more remote from each other, are looser and much less evidently fibrous than the two preceding. They are distinguished only because the mucous membrane of the larynx is reflected outward, and forms a depression between them and these latter.

C. MUCOUS MEMBRANE AND GLANDS OF THE LARYNX.

§ 2269. The larynx is covered internally by a reddish and smooth mucous membrane, which is uninterruptedly continuous above with that of the cavity of the mouth, and below with that of the trachea. The outer face of this membrane contains muciparous glands, which vary in size, and are united in bundles. One of these glands, the *arytenoid* (*G. arytenoidea*), is situated before the arytenoid cartilage. Another is larger, imbedded in the midst of fat, and is termed the *epiglottid* gland (*G. epiglottidea*); it occupies the space between the epiglottis, the tongue, and the hyoid bone. It opens by from twenty to thirty excretory passages, which pass through the epiglottis, and the origins of which are easily seen on the inner face of the mucous membrane and the epiglottis.

§ 2270. The mucous membrane forms on each side a considerable depression, termed the *ventricle of the larynx* (*ventriculus laryngis*). This depression is situated between the superior and inferior thyro-arytenoid ligaments; it is at most but one line deep, and two broad. It extends then much farther from before backward, than in any other direction. It is covered below by a considerable number of muciparous glands.

D. MUSCLES OF THE LARYNX.

§ 2271. The muscles of the larynx are divided into those which move the whole apparatus, and those which move some of its cartilages.

I. GENERAL MUSCLES OF THE LARYNX.

§ 2272. The general muscles of the larynx are the sterno-thyroideus and the hyo-thyroideus.

a. Sterno-thyroideus.

§ 2273. The *sterno-thyroideus* muscle (*M. bronchius*), is thin, oblong, and considerably contracted from below upward. It arises from the posterior face of the handle of the sternum, and the inner part of the posterior face of the cartilage of the first rib, ascends directly before the trachea, covered by the sterno-hyoideus muscle, and is attached by an oblique edge, formed of very short tendinous fibres, to the oblique line of the thyroid cartilage. It is generally blended at its outer part with the thyro-hyoideus muscle, and it is cleft in a greater or less extent.

Its external face generally presents, some distance from its lower extremity, a transverse or oblique tendinous intersection.

Sometimes there are two of these muscles placed one above the other.(1) It depresses the larynx, by acting on the thyroid cartilage. Its union with the following muscle causes it to depress the hyoid bone.

b. Hyo-thyroideus.

§ 2274. The *hyo-thyroideus* muscle has an oblong square form : it gradually contracts from below upward, and at the same time becomes thicker in the same direction. It arises from the oblique line of the thyroid cartilage, directly above the upper edge of the preceding, and ascends along the outer part of the lateral face of the thyroid cartilage, to arrive at the great horn of the hyoid bone, and is attached to the anterior part of the lower face.

It raises the thyroid cartilage and the larynx, when the hyoid bone is fixed, and depresses it when the latter is not fixed, so that it contributes by the first of these two actions, to produce acute sounds, and by the second to deglutition.

II. SPECIAL MUSCLES OF THE LARYNX.

§ 2275. The special muscles of the larynx are those which dilate and contract the glottis.

A. MUSCLES WHICH DILATE THE GLOTTIS.

a. Crico-thyroideus.

§ 2275. The *crico-thyroideus* muscle (*M. crico-thyroideus*, s. *dilatator glottidis anterior*), is very small, and nearly rhomboidal, and its

(1) Gunz, *Obs. anat.*, in the *Mém. prés. a l'ac. des sc.*, vol. i. p. 286.

figure is a slightly inequilateral square. It is covered by the sterno-thyroideus muscle, and is situated between the lateral faces of the thyroid and the lower edge of the cricoid cartilage. It arises from the lower edge and the lateral face of this latter. Its fibres are directed obliquely from below upward, and from before backward, and are often divided into two distinct fasciculi, an anterior and a posterior. It is attached by a short tendon to the lower edge, and the inferior horn of the thyroid cartilage.

It is used to draw the sides of the thyroid cartilage downward and outward, so that it enlarges the glottis.

b. Crico-arytenoideus.

§ 2277. The *crico-arytenoideus* muscle (*M. crico-arytenoides*, s. *dilatator glottidis posticus*), is rhomboidal, and fills most of the posterior face of the cricoid cartilage. It arises from its whole extent, ascends from within outward, and is attached by a short tendon to the outer edge of the arytenoid cartilage.

It draws this cartilage outward, turns it a little on its axis, and thus dilates the glottis, especially at its posterior part.

B. MUSCLES WHICH DILATE THE GLOTTIS.

a. Crico-arytenoideus lateralis.

§ 2278. The *crico-arytenoideus lateralis* muscle is small, and of an elongated triangular form. It extends obliquely from before backward, and from below upward, from the posterior part of the upper edge of the lateral portion of the cricoid cartilage, to the lower part of the outer face of the arytenoid cartilage.

b. Arytenoides obliquus et transversus.

§ 2279. The *arytenoides obliquus* and *transversus* muscles being united very intimately, should be considered as forming a single muscle, the different layers of which do not follow the same direction.

The *oblique* fibres form the two posterior and weaker layers. They arise from the lower part of the outer edge of the arytenoid cartilage, above the insertion of the crico-arytenoideus muscle, ascend obliquely towards the opposite side, and becoming broader and thinner, are attached to the outer edge of the arytenoid cartilage of the opposite side.

The fibres which come from the left arytenoid cartilage, usually cover those arising from the cartilage of the other side.

The *transverse* fibres are partly covered by the preceding, and are attached by their two edges to the posterior face and the external edge of the two arytenoid cartilages.

All these fibres bring together forcibly, the two arytenoid cartilages, and thus contract the glottis, especially at its posterior part, in a transverse direction.

c. Thyro-arytenoideus.

§ 2280. The *thyro-arytenoideus* muscle (*M. thyro-arytenoideus*) is very elongated; it arises from the centre of the inner face of the thyroid cartilage, from the pyramidal ligament, sometimes also from the lower part of the epiglottis, goes backward and a little upward, and is inserted at the lower part of the outer edge of the arytenoid cartilage, directly above the upper extremity of the crico-arytenoideus lateralis muscle, with which it is blended.

Sometimes we observe, still higher, another and smaller synonymous muscle.

These two muscles draw the arytenoid cartilage forward, and thus contract the glottis from before backward. They diminish the extent of the glottis more than any other muscle. The fibres which go to the epiglottis, are inserted in this cartilage.

d. Thyro-epiglotticus.

§ 2281. The *thyro-epiglotticus*, or the *depressor epiglottidis* muscle, arises from the centre of the inner face of the thyroid cartilage, and is inserted on the lateral edge and the lower part of the epiglottis.

There is sometimes a smaller one, which arises farther inward and upward.

These two muscles depress the epiglottis.

F. NERVES OF THE LARYNX.

§ 2282. The nerves of the larynx arise from the pneumo-gastric nerve, and are the superior laryngeal and the inferior laryngeal or recurrent nerve. Both are distributed in the mucous membrane and in the muscles.(1)

(1) Magendie (*Physiologie*, vol. i., p. 206) and Cloquet (*Traité d'anatomie*, vol. ii., p. 622) think the first of these nerves goes wholly or nearly so to the crico-thyroidei posticus and laterales muscles, and also to the thyro-arytenoideus. Hence, whether the different muscles contract or dilate the glottis, they receive all their filaments from one of these two nerves, and completely dividing or tying them, enfeebles the voice, which is entirely lost when both are divided. Rudolphi (*Physiologie*, vol. ii., p. 375) remarks that this description is incorrect, and that we must adopt that of Anderseh and Sœmmerring, whose neurology is followed by Meckel. In fact, the superior laryngeal nerve anastomoses by some twigs with the recurrent nerve within the larynx; the two nerves send twigs also to the muscles which contract and dilate the glottis, and the recurrent nerve sends some to the crico-thyroideus muscle. Anderseh (*Tract. de nervis hum. corp. aliquibus*, p. i., Koningsberg, 1797, p. 50) mentions a case where the two nerves did not anastomose in the larynx, but expressly

G. FUNCTIONS OF THE LARYNX.

§ 2283. The mucous membrane of the larynx is extremely susceptible, on account of the great number of nerves which it receives, particularly in the region of the glottis. This sensibility prevents foreign bodies from entering the trachea, where they would inevitably cause suffocation. It is curious that it is so developed only at the upper part of the air-passages, and that the mucous membrane of the trachea does not possess it.

The vitality of the larynx is manifested principally by its motions, which are of two kinds. In fact:

1st. They extend to the whole system, or are confined to some of its component parts.

2d. They move in several different cases, and are connected with several functions.

The general motions of the larynx vary its relations with the adjacent parts, according as it is drawn upward, downward, forward, or backward. The partial motions change the mutual relations of its constituent parts, and vary particularly the form and extent of the glottis.

The whole larynx moves in speaking and deglutition.

During deglutition, the larynx is drawn forward and upward, as we have already explained, which prevents the food from entering it.

In speaking, the larynx rises in acute sounds, both to raise the thyroid from the cricoid cartilage, and thus to contract the glottis, and at the same time to tense its ligaments, so as to lengthen and contract the trachea. In low tones, on the contrary, it is depressed to produce opposite changes.

The partial motions are connected with deglutition, respiration, and speaking.

In fact, in deglutition, the glottis is so contracted by the action of its constrictor muscles, that, even were the epiglottis absent, the food would not necessarily and constantly fall into the air passages.

In respiration, the glottis is dilated during inspiration, and contracted in expiration; these changes constantly occur, even when the voice

states that this is not the common arrangement. When it may be as true that it is not, says Rudolphi, that the constrictor muscles and those which dilate the glottis receive distinct branches from the par vagum, what must we conclude? One nerve causes the contractions in muscles which contract and those which dilate the glottis; it is then unimportant which these muscles receive. But the fact that the same muscle receives twigs from the upper and from the lower nerve is very important, since the action may take place in one direction when a ligature or section prevents it in the opposite, and it is still more so as the pneumo-gastric nerve anastomoses above and below with the great sympathetic nerve, and above with the glosso-pharyngeal, the accessory, and the hypogastric nerves, so that the inner nerves of the larynx certainly come from several different sources. F. T.

cannot be formed, on account of an opening in the trachea.(1) Farther, this is not surprising, since they coincide with analogous changes which supervene simultaneously in the trachea, of which the larynx must be considered the upper enlarged and more developed part.

From Legallois' experiments the closing of the glottis is the cause of rapid death in suffocation, which occurs in certain cases from dividing the pneumo-gastric nerve or the laryngeal branch, particularly in youth, as in such states the glottis always appears very much contracted.(2)

The fact is correct, but the mode of explaining it by the paralysis of the arytenoidei muscles is only partially true. The contraction and even the closing of the glottis from the paralysis of the muscles to which the recurrent nerve is distributed, seems to depend rather on the predominance of the muscles, the nerves of which are unaltered, and therefore caused only in part by the paralysis.

In fact in animals of a certain age, in which the operation is less dangerous on account of the size of the glottis, this opening is almost entirely closed after dividing the two recurrent nerves, while it is closed but imperfectly when the superior laryngeal nerves are cut, and the power of forming it is lost after separating all the nerves of the larynx.(3)

The special motions of the larynx are very remarkable in forming the voice.

At each tone the glottis contracts, and the more the louder the tone is.(4) The contraction occurs particularly from one side to the other; sometimes also from before backward, and often in every direction at once.

§ 2284. The larynx is the organ of the voice. This is proved:

1st. By the loss of voice, without any derangement in the respiration, when the trachea presents an opening through which the air enters and emerges in inspiration and expiration.

2d. By the diminution or the total loss of voice when some parts of the larynx, as the vocal cords have been destroyed, or the arytenoid or cricoid cartilages, or the laryngeal nerves are divided.

3d. By the differences in the voice, dependent on those in the arrangement of the parts of the larynx.

The voice is formed in the glottis, since the power of producing it is lost when the crico-thyroid ligaments are divided, and the removal of the upper half of the arytenoid cartilages and the longitudinal section

(1) Bichat, *Anat. descript.*, 1802, vol. ii., p. 405.—Legallois, *Exp. sur le principe de la vie*, Paris, 1812, p. 198.—L. Mende, *Ueber die Bewegung der Stimmritze beim Athemholen, eine neue Entdeckung; mit beygefügten Bemerkungen uber den Nutzen und die Verrichtung des Kehldeckels*, Gripswald, 1816.

(2) Legallois, p. 197.

(3) Magendie, *Sur l'épiglotte*, p. 4.

(4) Ferrein (*Mém. de Paris*, 1741, p. 559) has already opposed the opinion hitherto existing, viz. that the contrary is true. Bichat has followed in the same track (*Anat. descr.*, vol. ii., p. 408).

of the thyroid cartilage produces the same effect, which is always observed in the contraction of the glottis in crying, as the destruction of the upper ligaments has no effect on the voice, and as these ligaments likewise are always too far from each other to contract the glottis(1) transversely.

§ 2285. We have now to determine how the voice is formed in this place. Some suppose it is owing to the vibrations of the air, as in a wind-instrument.(2) Others assert that it is produced by the vocal cords, as in a stringed instrument.(3) Finally, several have combined these two theories.(4)

The first has been supported:

1st. By the analogy of the air-tube with a wind instrument, in which the formation of the different sounds is produced by modifying the diameter of the opening.

2d. By the comparison with the lips, where the same conditions occur.

3d. By different experiments proving:

a. That the tension or relaxation of the vocal cords has no effect on the acute or grave character of the sound, inasmuch as the glottis is dilated or contracted by them.

b. That when one of the vocal cords is tense and the other relaxed, they do not produce two different sounds, but one sound, the acuteness of which is proportional to the breadth of the glottis.

c. That the tone does not change when we touch the vocal cords.

d. That the contraction of the glottis is sufficient to render the tone more acute, and its dilatation to depress it, although the tension of the vocal cords does not change, and independent too of their form.

e. That the sound is independent of the force with which the air leaves the lung.

f. That no tones are formed when the glottis is very much dilated, and the vocal cords are very tense, and the air is forcibly expelled from the lung.(5)

(1) E. Grasinow has asserted (*Russiche Jahrbücher*, vol. ii., pt. i., p. 125–143) that the voice is formed in the trachea. Burdach has refuted this absurd opinion (*same journal*, p. 153–160).

(2) Fabricius of Aquapendente, *De larynge*, p. ii., c. iv. *Vocis opifex, causa seu organum inquiritur.*—C. F. S. Liscovius, *Diss. sistens theoriam vocis*, Leipsic, 1814, p. 28–37.

(3) Ferrein, *De la formation de la voix dans l'homme;* in the *Mém. de Paris*, 1741, p. 545.

(4) Galien, *De usu partium*, vol. vii., p. 10.—Casserio, *De larynge*, book ii., ch. xiv., *De glottide.*—Dodart, *Mém. sur les causes de la voix de l'homme et de ses différens tons;* in the *Mém. de Paris*, 1700, p. 308.—Id., *Supplémens aux mémoires sur la voix et sur les tons;* same journal, 1706, p. 169 and 500; 1707, p. 83.—Dodart, however, attributes most influence to the vibrations of the air; it is then difficult to understand why modern physiologists, even neglecting Fabricius of Aquapendente, should maintain that Ferrein's opinion was the only one admitted, and present the theory as new, and more so because Ferrein directly opposes the hypothesis of Dodart.

(5) Liscovius, *loc. cit.*, p. 29–34.

The second theory is supported :

1st. By the analogy of the vocal cords with stringed instruments.(1)

2d. By experiments which have proved that the extent to which the larynx was open had absolutely no effect on the acute or grave character of the sound,(2) while, on the contrary, the tone became acute as the vocal cords were carried outward and extended by the air leaving the lung, and was lower when the ligaments were compressed ; that it is modified in the same manner when these ligaments are fixed on several points ; that the different tones are produced when the degree of tension of the ligaments varied ; finally, that similar phenomena occur when the ligaments of the larynx are entirely detached, except at their two extremities.(3)

Hence, the degree of openness of the larynx would not cause a difference in the sounds, but only in the volume of the voice.(4)

Very probably the third opinion is most correct, although the experiments first mentioned prove, that the vibrations of the vocal cords contribute less to produce the voice than those of the air passing through the glottis ; they occur simultaneously, without being necessarily connected with speaking, and the more as the larynx and trachea vibrate very evidently when the air is blown in with force, although the voice is not necessarily produced.(5)

The acuteness of the voice in the female corresponds very well with the narrowness of the glottis, but not with the greater softness of the vocal cords.

§ 2286. But although the voice forms in the larynx, particularly in the glottis, the parts, however, before this opening, the epiglottis, the cavity of the mouth, and the nasal fossæ, also assist to form it.

Doubtless the principal function of the epiglottis is to close the larynx during deglutition, but very probably also it contributes to produce the voice.

In fact Haller has refused to it, contrary to the opinion of Tauvry,(6) and Santorini,(7) all agency in phonation, not because it exists before the fetus possesses a voice,(8) but because this latter is formed in the larynx, consequently below the epiglottis, and because birds sing although deprived of it.(9)

This view of the subject is supported by some experiments, which demonstrate that the force of the voice does not change, although we cut transversely between the larynx and the hyoid bone, draw the

(1) Ferrein, p. 566, 560.
(2) Id., p. 559.
(3) Ferrein, *loc. cit.*—Portal, *Exp. sur la voix* ; in his *Mémoires*, vol. ii., p. 308.
(4) Ferrein, p. 558.
(5) Liscovius, p. 34.
(6) *Nov. anat.*, Ulm, 1694, p. 408.
(7) *De laryngc*, § 10.
(8) Mayer, *loc. cit.*, p. 185, 186.
(9) *Epiglottis equidem nihil faciat ad vocem cum ea* (*vox*) *nata sit et perfecta quam primum aer ex glottidis rima prodiit et absque epiglottide aves suavissime canant* (*El phys.*, l. ix., pt. i., § v., p. 572).

epiglottis outward, and thus place the glottis directly opposite the external wound: that the removal of the top of this cartilage has no influence on the voice generally,(1) and that its depression, its elevation, and even its entire removal, have no effect on the character of the sounds.(2)

But these facts only demonstrate that the epiglottis is not absolutely necessary to phonation. Farther, the argument drawn from birds proves nothing, since their voice is formed in a lower larynx, and in them the epiglottis may be replaced by the whole trachea and by the superior glottis.

Finally, several observations and experiments, made with great care, admit the conjecture that the epiglottis alone, or together with the soft palate, contributes materially to the changes in the volume, tone, and modulation of the voice,(3) since its situation, direction, and form experience changes like those remarked in this respect in the voice, and we have no authority for admitting that these phenomena result from other changes which occur in the larynx, an opinion probably professed by Ferrein,(4) since the new organ of voice he maintains can hardly be the soft palate.(5)

In regard to the cavities of the nose and mouth we may remark, that the power and clearness of the voice are increased by its being retained in these two cavities, as is easily seen from the difference when the nose is stopped, or the pituitary membrane is swelled.

Farther, the different inflexions of the voice, which are termed *letters*,(6) are produced both by the larynx and the different parts of the oral cavity.

The *vowels* are formed principally in the canal included between the tongue and the palate. Their differences depend almost entirely on those in the diameter of this canal, caused by the motions of the tongue.

On the contrary, the epiglottis and the different parts of the mouth, especially the lips and the soft palate, have great effect on the formation of the *consonants*.

II. SEXUAL DIFERENCES IN THE LARYNX.

§ 2287. The larynx is one of the organs which presents most manifestly the differences of sex. That of the female is usually one third and sometimes one half smaller than that of the male; all its constituent cartilages are much thinner; the thyroid cartilage also is even flatter, because its two lateral halves unite at a less acute angle.

(1) Bichat, *Anat. descript.*, vol. ii., p. 402, 404.
(2) Liscovius, p. 34.
(3) Magendie, *Physiol.*, vol. i., p. 221.—Mayer, *loc. cit.*—Mende, *loc. cit.*
(4) *Sur la formation de la voix;* in the *Mém. de Paris*, 1741, p. 574.
(5) Haller, *loc. cit.*, p. 455.
(6) Kempelen, *Mechanismus der menschlichen Sprache, nebst der Beschreibung seiner sprecaenden Maschine*, Vienna, 1791.

Hence why the larynx in the male forms at the upper part of the neck a prominence which is not visible in the female. From the same cause also the groove in the upper edge is much more superficial in this latter than in the male.

The glottis in the female is much smaller than in the male, and the vocal cords are shorter.

III. DIFFERENCES IN THE LARYNX DEPENDENT ON AGE.

§ 2288. The sexual differences we are about to mention do not appear until puberty: until then the larynx has precisely the same form in the two sexes, and consequently the voice is nearly the same in both. In eunuchs it is small as in females.(1)

This organ developes itself much more slowly than other organs, and not proportionally with them: it seems less regular in respect to its periods, so that the larynx is sometimes smaller in some children than in others who are younger, although the growth of the others corresponds perfectly to their age.

The larynx, especially the glottis, generally continues small for a long time; thus it differs but slightly in a child of three and one of twelve years of age. But the difference is suddenly so great at the period of puberty, that in the course of a year the glottis doubles in breadth and length.(2)

IV. ABNORMAL STATE OF THE LARYNX.

A. DEVIATIONS IN FORMATION.

§ 2289. The whole larynx or some of its parts rarely present primitive deviations of formation.

We, however, must mention here its unusual littleness, which depends on the permanence of its primitive formation, and which coexists with the destruction or imperfect development of the testicles,(3) the absence of the epiglottis,(4) the division of this cartilage,(5) the absence of the upper horns of the thyroid cartilage,(6) of the ericoid and the arytenoid cartilages,(7) which is very curious as it establishes an uncommon resemblance between the larynx and the trachea: the

(1) Dupuytren, *Bull. de la soc. phil.*, vol. ii., p. 195.
(2) Richerand, *Recherches sur la grandeur de la glotte et sur l'état de la tunique vaginale dans l'enfance;* in the *Mém. de la soc. méd. d'émul.*, vol. iii. p. 326.
(3) Dupuytren, *Bull. de la soc. phil.*, vol. ii., p. 195.—Meckel, *Handbuch der pathologischen Anatomie*, vol. i., p. 485.
(4) Targioni Tozzetti, *Prima raccolta*, Florence, 1752.
(5) Meckel, *loc. cit.*
(6) Sandifort, *Exerc. anat.*, l. ii., ch. vii., p. 64.
(7) Roederer, *De fœtu paralytico;* in the *Comm. soc. Gott.*, vol. iv., p. 136.

obliquity and curve of the epiglottis;(1) the imperfect division of the larynx by a cord which is directed from above downward.(2)

The consecutive deviations of formation,(3) especially those dependent on mechanical injury, are much more common than the primitive. We must distinguish among them wounds in the larynx made by a cutting instrument in suicide. Wounds of the epiglottis are generally considered as fatal; we however have one case before us, where this cartilage was entirely divided longitudinally, and also cut transversely in its right half; but death did not ensue. This case is curious also as it proves what we stated above, that the epiglottis is not absolutely necessary to close the glottis.

Wounds of the larynx are very frequently fatal, from their consequent irritation and inflammation, on account of its great sensibility.

Sometimes death occurs at the end of a certain time, being caused by the abundant granulations which completely obstruct the glottis, and which are formed in consequence of a wound which suppurates.(4)

The arytenoid cartilage is partially separated by a cutting instrument, and thus hanging in the glottis, may cause death by suffocation, like any other foreign body.(5)

The cartilages of the larynx are not necessarily fractured in persons who die by hanging, although they are sometimes broken.(6)

B. ALTERATIONS IN TEXTURE.(7)

§ 2290. The mucous membrane of the larynx either alone or with that of other parts, particularly the cavity of the mouth and that of the trachea, is often inflamed. Sometimes there is effusion, and an accidental membrane is formed, which more or less completely closes the glottis, and the patient is suffocated.

In phthisis laryngea also ulcers often exist which destroy it in a greater or less extent, and cause abnormal adhesions between it and the pharynx. This state also may cause suffocation in more than one way. But the swelling alone of the inflamed parts, without any effusion or ulceration, may be fatal.(8)

(1) *Atti di Siena*, vol. iii., p. 232.

(2) Meckel, *Handbuch der pathologischen Anatomie*, vol. ii., pt. ii, p. 140. The case cited by Otto (*Path. anat.*, p. 223), of a larynx divided into three, does not refer to this, but to the trachea, which presented three branches instead of two (Sandifort, *Exerc. ac.*, p. 65).

(3) G. Bell, *Cases of diseases and wounds of the larynx;* in his *Surgical observations*, London, 1817, p. 1.

(4) Bell, *loc. cit.*, p. 44.

(5) Ibid.

(6) Morgagni cites one case of rupture of the cricoid cartilage (*Ep. anat. med.*, vol. xix., p. 13).

(7) Bell, *loc. cit*,—Howship, *On the affections of the larynx;* in the *Practical observations in surgery*, London, 1816, p. 14.

(8) Howship, *loc. cit.*, p. 153.

The cartilages of the larynx are more subject than any others to ossify, and consequently to be affected with all the diseases peculiar to the bones.

Among the new formations cysts are not unfrequent in this organ, although much less common than the preceding anomalies. Sometimes they belong to the class of hydatids ; there is more or less danger of suffocation from them by closing the glottis.

C. FOREIGN BODIES.

§ 2291. As substances which pass into the stomach from the upper part of the alimentary canal must necessarily pass over the epiglottis, foreign bodies not unfrequently enter this organ, and thence pass into the trachea. This happens particularly when we talk while eating, as then the glottis is not closed. These foreign bodies soon occasion death by suffocation. A case however has been mentioned where a ducat continued two years in the larynx,(1) and another where a piece of a nut-shell as large as a finger-nail remained there seven years.(2)

ARTICLE SECOND.

ORGANS OF RESPIRATION.

I. NORMAL STATE.

A. LUNGS.

I. PERFECT STATE IN GENERAL.

§ 2292. The *organs of respiration* (*systema respiratorium*)(3) are the *lungs*, which communicate with the external air by the trachea. Beside the prolongations of the trachea, they are formed by the pulmonary arteries and veins, by lymphatic vessels, nerves, and cellular tissue between these two parts, and a serous envelop, the pleura.

(9) Hoechstetter, *Obs. med.*, dec. vi., c. x.

(1) Tulp, *Obs. med.*, l. ii., c. vii.

(1) M. Malpighi, *De pulmonibus epistol. I. et II. ad A. Borellum*, Bologna, 1661.—Th. Bartholin, *De pulmonum substantiâ et motu distribe. Acc. M. Malpighii de pulm. obs. anat.*, Leyden, 1672.—Helvetius, *Observations sur le poumon de l'homme ;* in the *Mém. de Paris*, 1718.—Wildrik, *De fabricâ pulmonum*, Franeker, 1761.—Wohlfahrt, *De bronchiis vasisque bronchialibus*, Halle, 1748.—Hildebrandt, *De pulmonibus*, Gottingen, 1786.—Reisseissen, *De pulmonum structurâ*, Strasburg, 1803.—Sœmmerring and Reisseissen, *Ueber die Structur die Verrichtung und den Gebrauch der Lungen*, Berlin, 1808.

A. FORM.

§ 2294. The *lungs* (*pulmones*) have the form of an irregular cone, the base of which looks downward and the summit upward. Their concave base rests on the diaphragm; their very convex external face is turned towards the ribs; the internal, which looks toward the heart, is concave.

The anterior edge is blunt, the posterior is sharp.

Each lung is divided into two triangular lobes, an upper, smaller, a lower, larger, by a deep groove which extends obliquely from above downward and from behind forward, and which passes entirely through it. Between these two lobes the right lung also presents a third, much smaller, which is situated forward, and contracts much from before backward. The left lung differs from that of the right side, as its lower edge presents a groove in which the lower part of the heart is situated.

Beside this difference in the form, the right lung is a little larger and lower but broader than the left, and this in return is a little more elongated.

Considered as a whole, the lung is divided into three, five, or six lobes, irregular in form and volume, in the spaces of which proceed the blood-vessels and the lymphatics, but the surface of which is not uneven, or but slightly so.

§ 2295. The posterior edge of each lung is cleft in most of its length, and thus presents a depression, the upper half of which receives the bronchiæ, the blood-vessels, and the nerves, while the ligaments of the organ are attached to the inferior.

The pulmonary artery is situated first entirely on the summit before the bronchia, and sends in this place a considerable branch to the lung; but it is soon directed backward, and passes behind the bronchia.

The pulmonary veins are found entirely forward and downward, excepting the smallest and lowest branches, which proceed behind the lowest ramifications of the bronchiæ.

B. SITUATION AND ATTACHMENTS.

§ 2296. The lungs are situated on the two sides of the heart. Each is inclosed in a special serous sac termed the *pleura*, with the parietes of which they are in perfect contact in every part, but do not adhere, except at the part where this membrane is reflected to cover their external face.

Their upper extremity passes a little beyond the first rib.

c. COLOR.

The color of the lungs when a person is in good health, is grayish red, more or less spotted with black.

D. TEXTURE.

§ 2297. Among the different parts mentioned as composing the lung, the trachea is the base of the others, and also the most important, as the air passes through it to enter and emerge from the lung.

a. Trachea.

§ 2298. The *trachea* (*tracheia et arteria aspera*) is a canal about four inches long and nine lines broad, which begins at the fifth cervical vertebra, below the larynx, and is covered only by some muscles, particularly the sterno-hyoideus and the sterno-thyroideus. It is situated exactly on the median line, passes directly before the esophagus, and descends directly into the chest, between the large vessels of the head. Thence it gradually inclines toward the right side, so that its left portion corresponds to the centre of the vertebral column, and divides at an obtuse angle behind the arch of the aorta, about opposite the third dorsal vertebra, into two lateral branches, termed *bronchi* or *bronchiæ*. The right bronchia is generally eight lines broad, one inch long, and the left is about half an inch broad, and two long. The direction of this latter is more perpendicular than that of the other: it is situated between the descending vena-cava and the azygos vein. The left turns below the arch of the aorta, and goes forward.

Each bronchia is covered with the pleura, proceeds obliquely from above downward, and from without inward, toward its corresponding lung, and on arriving there, divides into a superior and an inferior bronchia, each of which proceeds to a lobe. The lower branch of the right bronchia also soon subdivides into two twigs, a superior, which is smaller, and an inferior, which is larger, for the middle and the inferior lobe.

These canals ramify extensively within the lung, and represent a tree, terminated in every part of the surface of the organ in culs-de-sac, along which are distributed all the other component parts of the lung. The final ramifications, which are the most minute, and terminate in a cul-de-sac, are termed the *pulmonary cellules* (*cellulæ pulmonares*).

§ 2299. The trachea is formed by very different parts, viz. by fibrous tissue, cartilages, muscular fibres, and a mucous membrane.

a. Fibrous tissue.

§ 2300. The fibrous tissue is composed of longitudinal fasciculi, which do not form a continuous membrane, but leave between them nu-

merous oblong spaces. It constitutes the outer face of the trachea, and adheres intimately to the subjacent mucous membrane. Its vessels are more numerous than those in the other fibrous organs, and thus it resembles the fibrous tunic of the arteries.

From the great elasticity of this tissue, the trachea contracts to its former dimensions, after being distended longitudinally.

b. Cartilage.

§ 2301. The fibrous tissue of the trachea and of its ramifications, inclose pieces of cartilage, placed successively from above downward, on the two faces of which it passes, and adheres intimately. It, however, does not cover directly the surface of these cartilages, which are entirely developed by a special perichondrium.

The form, dimensions, and situation of these cartilages, vary in different parts of the trachea, and in its ramifications.

In the trachea they form imperfect rings, open at their posterior part, which surround the anterior and lateral parts of the passage. These rings are about two lines high, half a line thick, and an inch and a half long. They circumscribe about the two thirds of the trachea when in its greatest state of distension, and more than three fourths of its circumference when it is collapsed.

The number of its cartilages varies from sixteen to twenty.

Their form is more regular and more constant at the centre of the trachea than at its upper and lower extremities. In most of this canal, they generally form rings of equal extent, and of about the same height.

The first, on the contrary, is much higher than the others, and higher at its anterior than at its posterior part. This arrangement establishes rather a remarkable correspondence from before backward, between it and the cricoid cartilage, in which there is an opposite arrangement.

This ring, also, is most generally united at its posterior extremity with the second whence results an undoubted analogy with the type of the formation of the larynx.

Sometimes there is a similar adhesion between the third and the fourth ring, either on both sides, or more commonly on one only.

The lower rings, on the contrary, frequently present on one or both sides, a greater or less fissure, that is, one which sometimes extends to their lower extremity, and sometimes stops short of it. Frequently, but not always, we then remark on the opposite side, a small segment of an imperfect circle, which corresponds to one of the two halves formed by the division, or a ring cleft on the other side, which in some measure makes up for the want of symmetry. But we as commonly find there a common and perfect ring, or one which is partly divided in the same manner and on the same side.

The rings of the loose portion of the bronchiæ are generally similar to the final cartilaginous rings of the trachea.

There are generally but eight in the right bronchia, while there are eleven or twelve in the left. As they approach the lungs, they become more irregular, and are divided or blended with the rings adjacent.

The number of the cartilages suddenly diminishes very much within the lungs, so that the ramifications of the bronchiæ become more membranous there. But, at the same time, these cartilages lose their regular form: they cease to represent rings, and resemble layers which are irregularly quadrilateral, triangular, &c. Besides, we find them in all parts of the trachea.

They become smaller and rarer, in proportion to the gradual contraction of the ramifications of the bronchiæ. The last which are perceptible have a rounded form.

We find none in those ramifications about one third of a line in diameter, or at least they are extremely small, and scarcely perceptible.

Finally, the last ramifications of the bronchiæ are simply membranous, and some lines below the surface of the lung, we find no trace of cartilage.

c. Muscular fibres.

§ 2302. The posterior part of the trachea is formed by a muscular membrane,(1) which is about half a line thick when it is contracted. This membrane is composed only of transverse fibres, which are attached to the cartilaginous rings, and to the fibrous tissue between them, so as to cover the inner face of these rings, and of this tissue about from one to two lines.

Within the lung, where the cartilages are arranged irregularly, and distributed on the whole extent of the bronchial tree, these muscular fibres surround also the whole trachea. They increase inversely as the cartilages, and they can be traced farther than these latter.

d. Mucous membrane.

§ 2303. The fibrous tissue and the muscular tissue of the trachea are covered in their whole extent by a thin mucous membrane, which forms a continuous sac, and adheres intimately to the adjacent parts.

Its posterior face presents in the whole extent of the trachea, mucíparous glands, arranged compactly, which are more numerous and larger at the lower part of the trachea, where it bifurcates, and in the portion of the bronchiæ and of the lungs. They are very near in these different parts, and they are frequently as large as a bean.

They form a continuous layer, situated mostly behind the muscular membrane, between the fibres of which their very short excretory pas-

(1) Eberhard, *Diss. de musculis bronchialibus eorumque in statu sano vel morboso actione*, Marburg, 1817.

sages penetrate. This layer extends uniformly on the portion of the trachea formed by muscular fibres, while the glands are principally collected between the cartilaginous rings, so that after removing these latter, we easily perceive the place they occupy by the spaces in the glandular layer.

We must distinguish from these muciparous glands, the bronchial lymphatic glands (*G. bronchiales*), which are found in the same places.

§ 2304. The mucous membrane is the last part visible among those which contribute to form the trachea and its ramifications, although reason and observation unite to demonstrate that its irritability extends beyond the points where its muscular texture disappears.

The most minute ramifications of the trachea, which are formed by a homogeneous substance, terminate in a cul-de-sac, and are not continuous, as Helvetius asserts, with the cellular tissue which unites the different organic parts of the lung. The trachea forms a hollow tree, the twigs of which communicate by the branches, and the lateral of the trunks resulting from their union, but not by means of mucous tissue existing between these ramifications. This fact is established by numerous dissections and experiments.

The minutest twigs of the bronchial tree, when filled with air or any other fluid, present the same form and the same limits, either when examined with the naked eye, or with a microscope. If we fill a bronchia with air or any other fluid, so as to inject, for instance, a whole lobe, and one of the secondary twigs is afterwards tied, the part of the lung in which this latter is distributed remains swelled and distended, while that where the bronchial twig is not tied soon collapses.

b. Blood-vessels of the lungs.

§ 2305. The blood-vessels of the lungs are of two kinds. Most of the organ is formed by the *pulmonary arteries* and *veins*, the first of which carry venous blood, while the veins carry back to the left half of the heart this fluid, which has been changed by the action of the air into arterial blood, in the limit between the two systems.

The trunks of these vessels enter and emerge from the lungs at the same point.

Even within the organ the pulmonary veins are nearer the bronchiæ than the arteries are.

§ 2306. The second order of blood-vessels includes the *bronchial arteries and veins* (*vasa bronchialia*), which are connected with the nutrition of the lungs. We have already mentioned their origin. These vessels are distributed in the substance of the lung, along the ramifications of the bronchiæ, rest on their surfaces, and surround them with numerous plexuses. After supplying the muscular and the fibrous tissue, they penetrate to the mucous membrane, into which they send numerous ramuscules to the membranes of the pulmonary vessels, to

the nerves of the lungs, and form a very minute and complex tissue on the surface of all these parts, below the pleura.

It is very curious that the anastomoses occur, not only in this vascular net-work, but also between the considerable branches and twigs of the pulmonary and bronchial vessels.

The bronchial veins even mostly empty into the pulmonary. Those of the roots of the lungs alone unite in small trunks, which empty into the azygos vein, or the descending vena-cava, or into the subordinate twigs of the system of the veins of the body.

It follows then, from this arrangement:

1st. That even in the normal state the vascular systems of black and red blood communicate extensively in the substance of the lung.

2d. That analogous communications which appear in other parts as abnormal, as the termination of the coronary veins of the heart in the left ventricle, the insertion of one or more pulmonary veins into the vena-cava, the origin of a great pulmonary artery from the descending aorta, &c., are only a more marked development of this type.

3d. That in the cases where the pulmonary artery was obliterated or very narrow, and the subjects lived a long time, these anastomoses were probably large enough to carry the blood in the pulmonary arteries. In fact, the bronchial vessels were found very much dilated in a case of this kind.(1)

c. Lymphatic glands and vessels.

§ 2307. We have already made known the most important facts in regard to the distribution of the lymphatic vessels in the substance of the lung, and of the lymphatic glands which exist along the ramifications of the trachea.

d. Nerves.

§ 2308. The nerves of the lungs arise from the pneumogastric nerve. They are very small in proportion, but very numerous, and they can be traced far on the ramifications of the bronchiæ. They are divided into two orders. Some are distributed in the bronchial tree, others in the pulmonary vessels. The first penetrate to the muscular and mucous membranes, the second surround the vessels and penetrate either into the substance of the great trunks, or into the capillaries. Some extend even to the pleura.

e. Pleura.

§ 2309. The *pleura* is a serous membrane, the outer portion of which, termed the *costal pleura* (*pleura costalis*), covers the inner face

(1) Jacobson, in the *Deutsches Archiv für die Physiologie*, vol. ii. p. 134.

of the pectoral cavity, while the internal or reflected layer, termed the *pulmonary pleura* (*pleura pulmonalis*), covers the external face of the lung.

It adheres to the parietes of the chest less than to the surface of the lung: it however can be easily detached from this latter organ.

It is composed of a right and a left sac (*sacci pleuræ*), which are separate and entirely distinct.

The internal parietes of the external sac are not attached to the parietes of the pectoral cavity, but are turned towards each other, and form a septum which is directed from above downward, and from before backward, which divides the chest into a right and a left half.

These two internal parietes, however, do not touch. They are separated in the centre, and in most of the septum they form, by the heart: backward, by the aorta, the esophagus, the azygos vein, and the thoracic canal: forward by the thymus gland and the great vascular trunks. They are united in all these parts by very loose cellular tissue; and are most remote from each other in their centre. That portion of the septum situated before and behind the heart, is termed the *anterior* and *posterior mediastinum* (*mediastinum anterius et posterius*).

The *anterior* mediastinum descends between the heart and the middle anterior part of the thoracic cavity. Its direction is not perpendicular, but oblique from left to right. Besides, it does not correspond perfectly to the median line, but is thrown a little to the left, for the anterior edge of the right layer is attached to the left edge of the sternum, and that of the left layer to the cartilage of the left ribs; thence the mediastinum descends on the anterior face of the pericardium.

The *posterior* mediastinum is more perpendicular than the anterior, and is situated between the anterior face of the vertebral column and the base of the heart.

The external layer of the pleura of each side, is reflected on itself, between the two mediastina, to pass on the lower and upper faces of the lungs. For this purpose, it contracts around the pulmonary vessels and the bronchiæ, and descends from the centre of the posterior edge towards the lung. Upward, forward, and backward, it contracts suddenly, and from all parts towards this point; but we observe below, on each side, a considerable triangular prolongation, terminated by a lower semicircular edge, which begins at the diaphragm, and is attached to the posterior edge of the lower lobe of the lung. This prolongation is termed the *right and left ligament of the lung* (*l. pulmonis dextrum et sinistrum*). That of the left side is much larger than that of the right.

The pulmonary pleura covers the whole surface of the lung, even its lobes, but does not penetrate between these lobes, which are separated from each other only by cellular tissue.

f. Weight of the lung.

a. Absolute weight.

§ 2310. The sound lung of an adult male, with all the blood and the air it contains, weighs about four pounds. When removed from the body, the pressure of the external air, which had been prevented from acting on it, expels a considerable portion of this fluid which remained in it after the last expiration.

Its weight then is to that of the whole body about as 1 : 35.

b. Specific gravity.

§ 2311. Considered in itself, the substance of the lung is heavier than water, for the lungs of a child which has never breathed sink in this fluid. But when respiration has commenced the specific weight of the organ is less than that of water, as the air which enters there is not entirely expelled during expiration. We cannot even press it out from a section of the lung: for then, after rupturing the ramifications of the bronchiæ, it extends in the cellular tissue, so that at the end of the experiment the substance of the lung is still lighter than the water, although a little heavier than it was before.(1)

g. Capacity.

§ 2312. The capacity of the lung is not the same in all periods of life. It varies much, according as the organ is distended at the end of *inspiration* (*inspiratio*), or in that of contraction, at the end of *expiration* (*expiratio*).

The estimates given by authors vary, which may arise from a real difference in the capacity of the lung and the nature of the modes employed to estimate it.

In the first respect there are very great individual differences, which are mostly congenital, but which may be accidental, as when the lungs are but slightly used, for instance, in students.

The capacity of the lung is determined by adding the quantity of air expelled during expiration with that which remains there after this act is completed. This calculation may be made in several different ways.

Three processes can be used to determine the quantity of air which enters the lung at each inspiration:

1st. We may measure the enlargement of the lung in inspiration, and the contraction after expiration.

(1) Allen and Pepys, *Second paper on respiration;* in the *Phil. trans.*, 1809, p. 41.

2d. We estimate the changes which supervene during inspiration and expiration in a fluid in which the individual is situated.

3d. We measure the quantity of the air inspired and expired, by inspiring from a vase which has been measured, and expiring into another, the capacity of which is also known, or by the last proof alone.(1)

At present the estimates of the quantity inhaled and expelled at each respiration varies much, from three to forty cubic inches. In fact, Abildgaard estimates it at three inches ;(2) Wurzer(3) and Lametherie,(4) at eight or ten ; Keutsch,(5) between six and twelve ; Abernethy,(6) Lavoisier, Seguin,(7) and Davy,(8) at thirteen ; Borelli(9) and Goodwyn,(10) at fourteen ; Kite,(11) Allen, and Pepys,(12) at seventeen or eighteen ; Herholdt,(13) between twenty-five and twenty-nine ; Cavallo,(14) Jurin,(15) Sauvages,(16) Hales,(17) Haller,(18) Chaptal,(19) Bell,(20) Fontana,(21) Menzies,(22) and Richerand,(23) between thirty and forty cubic inches.

In estimating the quantity of air remaining in the lung after expiration, the following circumstances are attended to :

1st. After expiration, as long as the chest remains closed and the lungs are not removed, these organs contain more air than when separated from the body, because they collapse after opening the chest, and thus expel the air they contain.

2d. It is very difficult to expel the air which remains in the lung, and it can never be completely removed by the greatest possible pressure.

(1) Jurin, in Haller, *El. phys.*, l. viii., s. iii.
(2) *Neue Versuche über das Athmen und den Nutzen desselben ;* in the *Nordisches Archiv. für Natur-und Arzneywissenchafl*, vol. i., pt. i., p. 2.—Abildgaard however asserts in another place (*ibid.*, pt. ii., p. 206), that from two to seven, and sometimes even fifteen cubic inches enter.
(3) Gunther, *Darstellung*, p. 28.
(4) *Journ. de physique*, vol. xlvi., p. 108.
(5) *De act. gaz oxygenii per pulm. resp.*, Copenhagen, 1800.
(6) *Essays*, London, 1793, vol ii., p. 144.
(7) *Mémoire sur la respiration*, &c.
(8) *Researches concerning nitrous oxyd*, London, 1800, p. 433.
(9) *De motu animalium*, p. ii., prop. 81.
(10) *Recherches expérimentales sur les effets que produisent sur les animaux vivans la submersion, la strangulation*, &c., Paris, 1798.
(11) *Ueber Wiederherstellung scheinbar todter Menschen*, p. 19.
(12) *Loc. cit.*
(13) *Nordischés Archiv.*, vol. i., pt. ii., p. 207.
(14) *Ueber Anwendung der Gasarten.*
(15) *Diss. phys. math.*, London, 1732, diss. iv. ; in Haller, *De part. corp. hum. fab.*, vol. vi., p. 325.
(16) In Haller, *El. phys.*, vol. iii., p. 234.
(17) *Statical essays*, vol. i., p. 238.
(18) *El. phys.*, vol. iii., *loc. cit.*
(19) *Chemie ;* in *Bostock, Ueber das Athmen*, p. 189.
(20) *Anatomy*, vol. ii., p. 193.
(21) *Phil. trans.*, 1799, p. 349.
(22) *De respiratione*, Edinburgh, 1790.
(23) *Physiologie*, vol. i., p. 374.

Several methods have been proposed to estimate the quantity of air which remains in the lungs after expiration.

1st. After fixing the diaphragm as firmly as possible, the abdomen is tied and the lungs collapsed, by making an incision in the parietes of the chest, we fill the space between these parietes and the organ with water, which it is asserted should be equal in quantity to that of the air expelled from the lung by the pressure of the liquid, and also that of the external air introduced into the chest through the parietes.

2d. On opening the lung the air is received from it in a bladder adapted to the trachea, and it is measured;(1) the lung is then immersed in water, the specific gravity of which is about equal to that of distilled water, while its absolute weight is known: the quantity displaced is weighed, and we determine the cubic quantity of air it still includes.

From these two methods we may conclude the quantity of air remaining in the lung of an adult after a complete expiration to be about one hundred and ten cubic inches. In fact, Goodwyn has introduced from ninety to one hundred and twenty cubic inches of water in the space between the chest and the lung.

In Allen and Pepys' experiments, the quantity of air first collected was 31.580 cubic inches: the lungs, which weighed four pounds, and which from their weight occupied as much space as an equal quantity of water, displaced six pounds of the liquid, so that there still remained within them a quantity of air equal to an ounce of water, that is, 59.554 cubic inches. The total of these two sums gives a little more than ninety-one cubic inches, as the quantity of air remaining in the lung after expiration; but we may admit it as about one hundred and ten, on account of the pressure of the water on the mass of the lung, and the higher temperature during life.

If we add to these one hundred and ten cubic inches of air remaining in the lung after a common expiration, about thirty inches which leave the organ at each common expiration of a healthy adult,(2) we shall have one hundred and forty-five inches as the capacity of the lungs in common inspiration, so that the difference of capacity between the state of dilatation and collapse of the organ is about thirty-five inches.

But this difference increases very much when the respiration being deeper, the lung is unusually dilated and collapsed, because more air enters and leaves the lung at each time.

(1) Cline, in Allen and Pepys, *loc. cit.*

(2) We take this as the mean number: it seems to us that a lower estimate should be ascribed to an unusual smallness in the lung, or to careless calculation, and that a greater estimate depends upon an unusual development of the chest, or on a very deep respiration. Farther, we ought to mention that the air is dilated one sixth by the heat of the body.

Thus Seguin(1) inhaled in a very deep respiration one hundred and thirty inches of air, which would expand by the heat of the body to one hundred and fifty, so that then the capacity of the lung was equal to two hundred and sixty cubic inches. Kite estimates the capacity at three hundred cubic inches.

On the other hand, Jurin expired two hundred and twenty cubic inches,(2) and Herholdt, 208.(3) If we admit here that these expirations took place after a full inspiration, we ought to reduce the capacity of the lung to fifty-two and even to forty cubic inches, which estimate perfectly agrees with that formed by Davy by another method.(4)

In contrasting the estimates of Seguin and Jurin, and disregarding the diminution of the volume of the air expired, we find a difference of two hundred and twenty between the greatest dilatation and the greatest relaxation of the lung, that is, this latter state is to the other as 1 : 6.5.

h. Force of the lung.

§ 2313. The lung is not very sensible. Its transverse and its longitudinal muscular fibres, which are similar in their nature to muscles, give it the power of contracting, which, judging from experiments,(5) is exerted whenever its external or internal surface is stimulated, and which without stimulation(6) executes the motions which cannot be attributed to those of the parietes of the thorax, since they are simultaneous with these latter, and are observed when the parietes of the thorax are destroyed.(7) Consequently the air-passages contract actively during expiration ;(8) but all these phenomena, adduced to prove that the lungs possess a power of extension which allow them to dilate actively in inspiration, can be satisfactorily explained in another manner.(9)

(1) *Observations générales sur la respiration et sur la chaleur animale ;* in the *Journ. de physique*, 1790, p. 467.
(2) In Haller, *loc. cit.*, p. 326.
(3) *Loc. cit.*, p. 41.
(4) *Loc. cit.*, p. 409.
(5) Varnier, in the *Mém. de la soc. roy. de.méd.*, ann. 1779.
(6) Rudolphi, *Ueber das Athemholen ;* in his *Anat. phys. Abhandlungen*, p. 111.—Flormann, *ibid.*, p. 110.
(7) Bremond, *Expériences sur la respiration ;* in the *Mém. de Paris*, 1739, p. 455. —This author however adduces as proofs several phenomena which are by no means conclusive.
(8) J. Carson, *Mémoire sur l'élasticité des poumons ;* in the *Arch. gén. de méd.*, vol. ii., p. 134.
(9) J. D. Herholdt, *Ueber die chirurgische Behandlungen der Brustwunden, veranlasst durch neue Versuche über den Mechanismus des Athemholens ;* in the *Nordisches Archiv.*, vol. ii., pt. i., p. 44-60.

i. Function of the lung.

§ 2314. The function of the lung is respiration, which consists essentially in the change of venous into arterial blood by the expulsion of carbon and the absorption of oxygen. The atmospheric air enters into the organ during inspiration, and emerges from it loaded with carbonic acid during expiration; this change of the blood, and the cold produced by the evaporation of the water exhaled, are the most important functions of the lungs; but the variations in its capacity also affect the circulation, for the blood circulates more rapidly from the right half of the heart into the pulmonary artery during inspiration, and from the pulmonary veins into the left portion of the heart during expiration.

II. SEXUAL DIFFERENCES.

§ 2315. The lungs of the male are larger than those of the female, and the latter are more oblong than those of the male.

III. DIFFERENCES DEPENDENT ON DEVELOPMENT.

§ 2316. The lung presents considerable periodical differences,(1) in respect to its existence, situation, texture, color, contents, volume, and finally its absolute and relative weight.

1st. *Existence.* The lung is one of the last organs to appear. It begins to be distinctly seen about the end of the second month of pregnancy.

2d. *Situation.* From the greater proportional volume of the heart and its slight development, the lung is situated much more posteriorly before than after birth, so that sometimes it is not seen at all on opening the cavity of the thorax; consequently it covers the pericardium, and generally does not entirely fill the sac of the pleura, and hence does not touch the parietes of the chest.

3d. *Texture.* At the third month of pregnancy we begin to distinguish the cartilaginous tissue in the air-passages of the lungs. The lobules are at first united by a looser cellular tissue than that com-

(1) Meckel, *Mémoire sur le développement du cœur et des poumons dans les mammiferes;* in the *Journ. compl. des sc. méd.*, vol. i., p. 259.—Consult also on the difference in the lung of the child before and after respiration, G. J. Schmitt, *Neue Versuche und Erfahrungen über die Plocquetsche und hydrostatische Lungenprobe*, Vienna, 1806.—A. Lecieux, *Considérations medico-légoles sur l'infonticide*, Paris, 1811.—Magendie, *Sur la structure du poumon de l'homme, sur les modifications qu'éprouve cette structure dans les divers âges, et sur la première origine de la phthisie pulmonaire;* in the *Journ. de physiol. expérim.*, vol. i., p. 78.—Fleischmann, *Sur la formotion de la trachée-artère;* in the *Journ. compl. du dict. des sc. méd.*, vol. xvi., p. 141.—Id., *De chondrogenesi asperiæ arteriæ et de situ œsophagi abnormi nonnulla*, Erlangen, 1820.

monly seen, and they are also formed of small subordinate lobes, so that here, as in other parts, as the muscles, the homogeneous mass is at first divided into its great subdivisions, but afterward into the smaller parts.

4th. *Color.* The color of the lung is at first reddish white in the fetus, and is whiter the younger the fetus is. This organ gradually becomes of a deeper red, in proportion as it is better supplied with blood. After birth this tint is bright from respiration, and also becomes deeper. At twenty years the lung is gray, mottled with blue and black spots, and from this time its color becomes still darker, so that in advanced life it is more or less generally black or bluish black.

5th. *Contents.* The trachea and its ramifications contain after birth only air, and a small quantity of aqueous vapor and mucus. But this is not true of the fetus, where it is filled with the fluid of the amnion. By the laws of hydraulics, when the fetus swims in this fluid it enters the trachea, without any respiratory motion on the part of the fetus. It usually escapes after birth, and when it does not escape at this time, which is rare, it may suffocate the child.(1)

6th. *Volume.* The lung is at first much smaller ; it occupies much less space than the heart, and is easily blended with the very dilated auricles of this latter.

It does not acquire its normal proportional size till puberty.

7th. *Weight.* The absolute weight of the lung presents very remarkable periodical differences, which depend on the organ remaining inactive until after birth. In the fetus its specific gravity is greater than that of water, in which it sinks; but when respiration has once commenced, as it is never free from the air which has entered in it, its specific gravity is less than that of the water, and it floats.

§ 2317. Most of the differences mentioned, especially those in regard to situation, volume, color, and specific gravity, appear more or less at birth, and result from respiration.

The lung, becoming lighter from the effect of the air entering it and which never entirely leaves it, occupies also more space after respiration, and is situated more anteriorly, covers most of the pericardium, and is in contact with the parietes of the chest. The deep red color communicated to it by the venous blood before respiration, changes to a bright red when the new being breathes.

Finally the organ, which when collapsed received less blood, and was consequently lighter, becomes heavier when after being distended by respiration, it is more permeable to the blood.

Hence these differences have been thought sufficient to determine whether an infant was born living or dead. But as the specific gravity having diminished, the lung floats, which proof constitutes what is

(1) P. Scheel, *Commentatio de liquoris amnii asperiæ arteriæ fœtuum humanorum natura et usu ejusque in asphyxium neonatorum et medicinam forensem influxu*, Copenhagen, 1799.—Herholdt, in Reil, *Archiv. fur die Physiologie*, vol. iii., p. 163.—Id., in the *Nordisches Archiv.*, vol. i., p. 212.

termed the *test hydrostatica*;(1) as also the afflux of the blood increases the absolute weight of the organ, and its relative weight compared to that of the body constitutes another kind of proof, termed the *test by the balance*,(2) this principle has been laid down, that when the lungs of a child swim in water, and a similar or analogous proportion exists between the relative weight of the lungs and that of the body, it is established that this child was born alive and that it breathed.

Considered generally and absolutely, these conclusions are correct; but great and important restrictions are necessary.

1st. The lungs may become lighter by respiration, and the child not be born.

2d. The lungs may swim from some other cause than respiration.

3d. Respiration does not necessarily produce this change in them.

4th. The lungs sometimes have a greater absolute weight, although respiration has not taken place.

5th. On the other hand, they may present after respiration a specific gravity as great as that they possess, according to the general opinion, before this act.

In fact:

1st. The infant sometimes breathes sufficiently during parturition to render its lungs capable of swimming, although it may be still-born.(3)

2d. The lungs may also swim from the fact that the air has been pushed into them, through the mouth or nose, either while they continued in the thorax, or after their removal from this cavity. Putrefaction also may give rise to the same result.

3d. Several experiments demonstrate that respiration does not necessarily cause in the lungs the above mentioned changes. Some parts of a lung, or even an entire lung, have been seen which did not swim in water, although the child has lived, breathed, and cried, not only for several days,(4) but even for six weeks. We have seen in a child six weeks old all the middle lobe of the right lung, and in another four weeks old, great portions of the same lobe apparently healthy, which were absolutely incapable of floating.

The left lung is most frequently retarded in its development, which peculiarity doubtless depends on the fact that the right bronchia is much shorter and broader than the left, so that usually, even in children who died soon after birth, the right lung floated, while the left floated very imperfectly, or not at all.(5)

(1) F. Alberg, *De docimasiâ pulmonum hydrostaticâ*, Halle, 1791.

(2) G. G. Plocquet, *Comm. med. in processus criminales super homicidio, infanticidio et embryoctonia*, Strasburg, 1787.

(3) Schmitt (*loc. cit.*, p. 150–176) has reported examples of this.

(4) Kaltschmied, *De exp. pulm. infant. aq. injectis*, ann. 1751.

(5) A. Portal. *Mémoire dans lequel on démontre l'action du poumon sur l'aorte pendant le temps de la respiration, et où l'on prouve que, dans l'enfant qui vient de*

It is at least very rare that the contrary occurs.

a. The rarest case is when the cause of the sinking of the lung depends on a morbid alteration in its texture, an effusion, an induration, for these are very unfrequent before birth, and even when they occur to a great extent, the organ does not acquire a greater specific gravity than that of water.

b. A more common cause is the presence of foreign bodies, especially mucus, and the fluid of the amnion in the trachea, or the feebleness of the fetus, all which circumstances render the dilatation of the lung imperfect.

c. We must remark also that this change in the specific gravity supervenes gradually, and when the respiration takes place with the requisite degree of strength, as in the beginning, and when the child respires but feebly, it extends to some parts of the lung only, and sometimes it is not produced at all by the first inspirations.

4th. Sometimes, although the child has not breathed, the lungs have an absolute and consequently a relative weight, in proportion to the body, as great as when the child has respired. There are some cases where the relation between the weight of the lung and the body is still greater, for instance, as 1 : $15\frac{1}{4}$, to $29\frac{2}{5}\frac{0}{3}$, to $33\frac{5}{9}$, to $32\frac{1}{5}\frac{4}{3}$, to $34\frac{7}{1}\frac{5}{3}\frac{}{1}$,(1) although respiration did not take place.

This circumstance is still more curious, as the lungs contained also more blood than usual.

5th. Observation likewise proves that the lungs of infants born alive are sometimes proportionally lighter than those of still-born children are, according to the preceding estimate,(2) as they are found in the proportion of 1 : $77\frac{9}{1}\frac{}{1}$, to $77\frac{1}{3}\frac{9}{8}$, and to 104.

II. ABNORMAL STATE.(3)

§ 2318. *Primitive deviations of formation.* The lungs present proportionally but few anomalies resulting from a primitive deviation of formation; they however sometimes manifest them in respect to quantity and quality.

1st. The congenital anomalies in regard to quantity are generally:

a. Deviations of formation from an arrested development. Here are arranged particularly:

a. The *absence* of the trachea, of a lung, or of the two lungs; this last anomaly usually attends acephalia vera; the second is more rare,

naître, le poumon droit respire avant le gauche; in the *Mém. de Paris*, 1765.—Some writers have attributed this discovery to Petit, but wrongly: he mentions only one case (*Mém. de Paris*, 1753), and does not point out the real cause of the phenomenon.

(1) Schmitt, *loc. cit.*, p. 138.

(2) Id., *ibid.*

(3) Van den Bosch, *Commentatio exhibens anatomiam systematis respirationi inservientis pathologicam*, Harlem, 1801.

and also occurs in subjects whose formation is otherwise normal, and resembles the normal singleness of the lung in several serpents. The absence of the trachea is less common than that of the lungs; when it occurs the lung is situated next to the larynx, as also in several reptiles.

b. *Narrowness* and *closing* of the trachea, which has been observed when the skull was deficient.(1)

c. The *smallness* of one or of the two lungs. The first anomaly is generally produced mechanically by an external obstacle, particularly the presence of the abdominal viscera in the cavity of the thorax in a subject affected with diaphragmatic hernia. The second, which is generally connected with narrowness of the thoracic cavity, depends on a primitive dynamic anomaly of the formative power, and sometimes occurs in individuals otherwise well formed, and sometimes is attended with other deviations in formation, arising from suspended development.

d. We ought also to mention here the exposure of the lungs or trachea sometimes observed, since it depends upon the formation of the parietes of the thorax being arrested at one of the early periods through which it successively passes.

b. The great size of a lung, attended generally by the deficiency of the other, results from an excessive action in the formative power.

2d. Congenital deviations in form relative to the quality are:

a. The *abnormal division*, which is indicated in the lungs by the presence of an unusual number of lobes, or by the deeper separation of those always existing, and in the trachea by its division into three branches. This last anomaly, judging from facts hitherto collected, occurs only on the right side, and is curious as a repetition of the peculiar structure of the ruminantia and the cetaceous animals.

b. An opposite anomaly occurs when the lungs are not divided into lobes as usual, or when this division is not clearly indicated.

c. Lateral inversion is where the right lung has but two lobes and the left three. This anomaly commonly occurs only when there is a general lateral inversion.

Consecutive deviations of formation. The pure consecutive accidental deviations of formation are particularly *wounds*, which often suddenly cause death, on account of the considerable caliber of the vessels, but sometimes death occurs from the dangerous inflammation and suppuration of such important organs; but they are not necessarily nor always fatal.

We must mention here the abnormal communication with the other cavities, which sometimes occurs when the parietes are destroyed; the most remarkable is that which occurs in aneurism of the aorta.(2)

(1) Otto, *Monst. sex. disq.*, p. 10, 11.

(2) Richerand, *Observations sur l'ouverture des anéurysmes de l'aorte dans la trachée-artère et dans les bronches;* in the *Mém. de la soc. méd. d'emul.*, vol. iv., p. 515.

In this case, from the respective situation of the parts, the opening usually corresponds to the lower part of the trachea, or to the left bronchia.

§ 2319. *Alterations in texture.* They are:

1st. Inflammation, generally termed *pneumonia*, *bronchitis*, and *pleuritis*, according as the whole substance of the lung, the mucous membrane of the trachea, or the pleura, is affected.(1)

The most usual consequences of pneumonia are:

a. Thickening and *induration* of the tissue of the lungs, from an effusion often existing in a great degree, and then forming the state termed *hepatization* (*hepatisatio*)(2) The substance of the lung is then generally homogeneous, friable, brittle, grayish white, much thicker in texture, and sometimes possesses a specific gravity greater than that of water.

2d. *Suppuration.* Pus usually burrows for itself a passage into the bronchiæ. More rarely it is effused into the chest, constituting *empyema*, or into the adjacent organs, as the pharynx or the aorta.(3)

Bronchitis terminates sometimes by suppuration, sometimes by the formation of solid or hollow membranes, which fill this cavity and rarely adhere to its inner face. Very probably, however, the development of these accidental membranes is not always and necessarily preceded by an inflammation of the trachea.(4)

The consequences of pleuritis are:

(1) C. Hastings, *A treatise on inflammation of the mucous membrane of the lungs*, London, 1820.—T. Alcock, *Observations on the inflammation of the mucous membrane of the organs of respiration*, London, 1820.

(2) Bricheteau, *De l'hépatisation pulmonaire;* in the *Journ. compl. des sc. méd.*, vol. ix., p. 106.

(3) V. Laennec, *De l'auscultation médiate*, vol. i.—Andral, *Clinique médicale*, vol. ii.—Louis, *Observations relatives à la perforation du parenchyme du poumon;* in the *Archiv. gén. de méd.*, vol. v., p. 321.—Bouillaud, *Nouvelles observations sur la gangrène des poumons;* in the *Revue médicale*, vol. iv., p. 375.

(4) This proposition cannot be admitted. It rests upon a fact mentioned first by Bayle, and since enlarged upon by Andral, that sometimes in individuals affected with chronic bronchitis, even with an expectoration of pus, the mucous membrane is hardly rosy or even perfectly white in its whole extent. But ought not we then to admit that the tissue is discolored after death? Farther, it is remarkable that the softening and ulcerations are much more rare in the mucous membrane of the bronchiæ than in that of the intestine, and that the frequency of the ulcerations decreases from above downward. The inflammation of this membrane frequently terminates also in thickening, which causes the contraction of the bronchiæ. Hypertrophy even sometimes extends more or less to the external fibrous and cartilaginous tissues. We must not confound the contraction of the bronchiæ, which results from it, with that which comes from the compression of these canals by a tumor, among others by tumefied ganglions, which are rather common in children, or by an aneurism of the aorta. Chronic inflammation results also in a dilatation of the bronchiæ, to which Laennec first attracted attention, and which has been studied very carefully since by Andral, as have also the different alterations in the secretion of the mucous membrane of the bronchiæ. Consult on this subject: Laennec, *De l'auscultation médiate*, Paris, 1819, vol. i., p. 124.—Andral, *Observations sur quelques altérations organiques des bronches;* in the *Archiv. gén. de méd.*, vol. iv., p. 514.—Id., *Clinique médicale*, vol. ii., p. 1-85.—Bree, *Recherches sur les désordres de la respiration*, Paris, 1819.—Desruelles, *Traité théorique et pratique du croup*, Paris, 1824. F. T.

a. Thickening, induration of this membrane.

b. Effusion of serum, which when not coagulable in a great degree, causes *hydrothorax*, and which when coagulable produces the mutual adhesions of the contiguous surfaces of the pleura.(1)

The principal new formations in the lungs are *tubercles*.

3d. The repetitions of the normal tissues in the respiratory organs are rare. We must however refer to this the accidental membranes developed after pleuritis, because they are repetitions of the cellular tissue and the accidental ossifications(2) formed in the osseous tissue. These ossifications frequently appear as thin elongated laminæ, situated on the outer face of the pleura. They are more rare on the inner face of this membrane, in the form of rounded bodies, which at first adhere, but are finally detached. The pretended change of the pulmonary substance into cartilage is probably in most cases only an induration resulting from effusion. Sometimes however cartilaginous tissue is really developed accidentally in the lungs.

§ 2320. *Foreign bodies.* These are:

1st. Entozoaries, particularly hydatids which form in the substance or on the surface of the lung, and the hamularia subcompressa which exists in the trachea.

2d. Foreign substances accidentally introduced into the air-passages.

ARTICLE THIRD.

CAVITY OF THE THORAX.

§ 2321. The thoracic cavity contains, besides the lungs and their vessels, the heart, the commencement of the aorta, the trunks of the ascending and descending venæ-cavæ, the azygos vein, the thoracic canal, the esophagus, and the thoracic portion of the ganglionary nerve. We have mentioned previously the manner in which it is formed like a cage. Its upper extremity is generally the narrowest and its lower extremity the broadest part of the chest: at least it is generally much broader at its base than at its summit. It is convex on the sides, flattened forward, larger from above downward, and shorter from before backward than in any other direction, much longer posteriorly than anteriorly, and provided below with a more or less convex floor which is formed by the diaphragm. Posteriorly the bodies of the dorsal vertebræ imperfectly divide it into two halves.

(1) Laennec, *loc. cit.*, vol. i.—Andral, *loc. cit.*, vol. ii.—Id., *Observations sur l'inflammation de la plèvre diaphragmatique;* in the *Archiv. gén. de méd.*, vol. iii., p. 246.

(2) Rullier, *Note touchant un très grand nombre de pièces osseuses développées dans le tissu du poumon;* in the *Archiv. gén. de méd.*, vol. v., p. 271.

It is a little shorter on the right than on the left side, on account of the prominence of the liver.

The inner face of its parietes is covered in nearly its whole extent by the external layer of the pleura, which is there attached to it by a very short cellular tissue. Of the organs it incloses, the lungs and the heart are united to it by its surrounding serous membranes; the others directly by cellular tissue.

The division into a right and a left half, indicated by the bodies of the vertebræ, is completed by the mediastinum.

I. MOTIONS OF THE CHEST.

§ 2322. The chest is continually extended, enlarged, contracted; and the first state occurs in inspiration, and the second in expiration. The motions of the chest which determine them, produce a simultaneous dilatation and contraction in the air passages. The lung, being compressed when the chest collapses, expels the air within it, while it enters through the mouth and nose, when, the chest dilating, the obstacle from the collapsing of its parietes no longer exists.

The dilatation of the chest during inspiration, and its contraction in expiration, occur in every direction.

The greatest change is that in height. It depends partly on the depression of the diaphragm in inspiration, and its rising in expiration, partly also on the raising of the ribs by the intercostales and scaleni muscles.

The enlargement in the direction of the breadth, depends on the ribs being drawn outward.

The parietes of the chest follow exactly the motions of the lungs during respiration, and these two parts remain in contact, at least in the regular state, during expiration or inspiration, so that they are found in perfect contact after the strongest of all expirations, that which occurs at death.

II. DIFFERENCES DEPENDENT ON SEX.

§ 2323. The chest of the male is much larger than that of the female, as it is longer, broader, and deeper. Its capacity is also more uniform, so that it is proportionally a little broader, rounder, and more movable. The bodies of the dorsal vertebræ do not project as much.

III. DIFFERENCES DEPENDENT ON DEVELOPMENT.

§ 2324. The chest is proportionally the smallest of the three sphlanchnic cavities of the body during the early periods of existence, which depends particularly on the slight development and the inactivity of the lungs.

It possesses in the same proportion a greater degree of elasticity, because the costal cartilages are much longer in proportion to the ribs, than during the successive periods.(1)

It does not begin to move until after birth, and when the new being breathes for the first time.

IV. ABNORMAL STATE.

§ 2325. Sometimes the chest is only partially closed, from a primitive deviation of formation. When this anomaly exists on the anterior face or the sides, the internal organs are exposed; when in the lower wall, the abdominal and pectoral cavities abnormaly communicate, and some of the thoracic viscera enter the cavity of the abdomen.

The same also may be caused later by wounds, ulcers, &c. A common congenital deviation of formation is the abnormal smallness of the chest, which generally attends a corresponding defect in the development of the lung, and a disposition to tuberculous phthisis.

The alterations in the texture of the chest are principally different kinds of tumors, which occur in the mediastinum. These tumors sometimes become large, and compress the organs in the thoracic cavity so much, that the subject dies from the suspension of the circulation or nutrition.(2)

ARTICLE FOURTH.

GLANDULAR ORGANS SITUATED NEAR THE ORGANS OF VOICE AND RESPIRATION.

§ 2326. We find near the organs of voice and respiration, two imperfect glands,(3) the *thyroid* and the *thymus* glands, which are similar, not only as they both present the general characters of glands of their species, but also because they are situated directly on the median line, behind the anterior face of the body, before the organs of respiration, and because they even touch in the early periods of fetal existence.

These two glands possess numerous blood-vessels and lymphatics. They have no excretory ducts, but contain in their spaces a fluid different from their substance, and which is very evident in the thymus gland. The change of a considerable quantity of blood, which is pro-

(1) Compare the measures in regard to this subject, in Lobstein, *Sur la première inspiration de l'enfant nouveau né;* in the *Journal de médecine*, vol. xxxv. p. 311–312.

(2) Lænnec, *Sur le rétrécissement de la poitrine à la suite de certaines pleurésies:* in his *l'Auscultation médiate*, vol. i. p. 369.

(3) P. H. Bœcklen, *De thyroideæ, thymi et glandularum suprarenalium functionibus*, Strasburg, 1753.—J. F. Meckel, *Ueber die Schilddrüse, Nebennieren und einige ihnen verwandte Organe;* in his *Abhandlungen aus der menschlichen und vergleichenden Anatomie*, Halle, 1816, p. 1–277.

bably peculiarly modified, and the formation of their fluid, are the only functions which can be assigned to them with certainty. We then have reason to think their functions in the sanguineous system are analogous to those of the lymphatic vessels, that is, they are organs which contribute to perfect the formation of blood. This conjecture is rendered probable from the fact, that the blood which passes through their tissue, and the fluid which they prepare, soon enter the venous blood near its entrance into the lung.

I. THYROID GLAND.

A. PERFECT STATE.

§ 2327. The *thyroid gland* (*G. thyroidea*)(1) is situated forward and on the sides of the upper part of the trachea and pharynx.

It is composed of a centre, which is slightly contracted, thin, and about four lines high, termed the *isthmus*, and of two lateral portions or *horns*, which are directed from below upward, and terminate in a point.

The central part is situated directly below the larynx, and before the three or four upper rings of the trachea. The two horns extend below to the sixth or seventh ring, and above to the lower horn of the thyroid cartilage.

There is generally detached more or less from its centre, a median horn, which is generally single, rarely double, termed by Lalouette the *pyramid*. This horn is rarely perfectly cylindrical, and generally corresponds to the left side more than to the right,(2) which deserves to be remarked on account of the greater development of the hyoid bone, generally occurring on the same side. It reascends before the thyroid cartilage to the middle hyoid bone, and it terminates there, gradually becoming thinner. This horn exists more frequently than it is deficient.(3) We must then attribute to accident, or to careless dissection, the assertions of authors to the contrary.(4)

§ 2328. It is generally surrounded by a special and unmated muscle, the *levator gland. thyroideæ* muscle, the upper extremity of which is generally attached to the body of the hyoid bone; sometimes it does

(1) P. Evertze, *De glandulâ thyroideâ*, Leyden, 1708.—Santorini, *Obs. anat.*, ch. vi–xvii.—Duvernoy, *Obs. anat.*, 2, 3, 4; in the *Comm. Petrop.*, vol. vii. 1740, p. 216–218.—Lauth, *De glandula thyroideâ*, Strasburg, 1742.—Morgagni, *Ep. anat.*, Venice, 1763, vol. ix. § 30–40.—Uttini, *De glandulæ thyroideæ usu*: in the *Comm. Bonon.*, vol. vii. p. 15–23.—Lalouette, *Recherches anatomiques sur la glande thyroide*; in the *Mém. prés.*, vol. i. 1750, p. 159–175.—Gunz, *Obs. anat. I. sur la glande thyroide*, ibid., p. 283–284.—Schmidtmuller, *Ueber die Ausfuhrungsgange der Schilddrüse*, Landshut, 1804.—B. Hofrichter, *Mémoire sur la thyroïde*, in the *Journ. compl. des sc. méd.*, vol. x. p. 21.

(2) Duvernoy, *loc. cit.*—Lalouette, *loc. cit.*, p. 163.—Morgagni, *Ep.* IX. *a.* 34.—Schmidtmuller, *loc. cit.*

(3) We have most generally found it, and Morgagni (*Ep. anat.* x. a. 36) has observed it to be absent only six times in a great many cadavers.

(4) Schmidtmuller, *loc. cit.*, p. 29.

not extend so high, and is inserted in the lower edge of the thyroid cartilage. In the latter case the middle horn is very slightly developed.

This muscle participates in the asymmetrical arrangement of the middle horn of the thyroid gland, so that it generally belongs to the left half of this latter, more than to its right portion: it however is not always attached to the same side of the hyoid bone, or of the thyroid cartilage, but sometimes passes obliquely before the trachea or the larynx, to arrive at the opposite side. This arrangement, which apparently renders it still less symmetrical, although it really tends to re-establish the symmetry, occurs particularly when it is attached to the thyroid cartilage, and is then inserted in its inner edge, on the outside of the crico-thyroideus muscle.

§ 2329. Each of the lateral horns is generally two inches high, while the height of the isthmus is only one inch. The entire breadth of the gland is about eight inches; that of each horn is nine lines. The whole gland weighs about one ounce.

2330. The thyroid gland is of a dirty red color; its texture is firm and solid, its surface is smooth. It has no proper capsule, and is surrounded only by a condensed cellular tissue; it is composed of large and small rounded, irregular lobes, each enveloped by a cellular sheath, between which the vessels are distributed. It normally contains no cavity; however, when we make an incision, either into the lobes or between them, a fluid analogous to the serum of the blood, oozes in great abundance from the wound.

§ 2331. For a long time it has been disputed whether the thyroid gland has excretory ducts?

Several anatomists, as Vater,(1) Santorini,(2) Coschwitz,(3) and Schmidtmuller,(4) have thought they saw one or more passages which extended from the gland into the larynx or trachea. They have attempted to consider the middle horn as an excretory canal, both from its form and the openings in the larynx on a level with its upper extremity. But the observations in support of this opinion are so trivial, and the most distinguished anatomists who have made them, have thought them of so little importance, that as yet we have reason to consider, with Duvernoy, Morgagni, and others, the thyroid gland as having no excretory passage, or none except the lymphatic vessels.

As the thyroid gland is proportionally much larger during the early periods of life, and as particularly its middle horn is then much more developed than in the adult, perhaps the excretory canal exists at this period, and is obliterated as the development of the gland is arrested, so that the imperfect development of the glands from a deviation in formation, often results from the absence or obliteration of their excretory passages.

(1) *De nov. duct. salív. in lingua humana;* in Haller, *Coll. diss.*, vol. i. p. 63.
(2) *Loc. cit.*, p. 115.
(3) *Ductus salival. novus plurib. observ. illustr.*, Halle, 1729, p. 10.
(4) *Loc. cit.*, p. 45–51.

B. DIFFERENCES RELATIVE TO SEX.

§ 2332. The thyroid gland is more developed in the female than in the male, which constitutes a very remarkable sexual difference.

C. DIFFERENCES DEPENDENT ON DEVELOPMENT.

§ 2333. The thyroid gland is at first formed of two separate glands, one of which is much larger proportionally than it is when the body is entirely developed, softer, more vascular, and conscquently redder. Its middle horn, particularly, is much larger than it is subsequently.

D. ABNORMAL STATE.

§ 2334. The thyroid gland is sometimes, but very rarely, as Morgagni has remarked,(1) divided into two distinct and separate halves. This anomaly is very remarkable on account of its relations with the state of the organ in the carly periods of fetal existence, and because it occurs normally in most mammalia. An arrangement resembling it, is thc considerable narrowness of the central portion or of the isthmus. Sometimes only a portion of a lobe is separated from the rest of the gland.(2)

Rather a common deviation of formation, but which is most generally consecutive, and rarely congenital, is the enlargement of the thyroid gland, which constitutes *goitre* (*struma*); this is frequently enormous, and is endemic in the narrow valleys of mountainous countries: The goitre, however, by no means always depends simply on an increase in the size of the thyroid gland: it is frequently only a consequence of the development of new formations in the tissue of this organ, or at least presents a conplication of the two states.

Hypertrophy of the thyroid gland, when not endemic, is much more frequent in females than in males. It appears particularly at puberty,(3) gestation, parturition, and lying in.

The abnormal formations occurring in the thyroid gland, are principally repetitions of normal organic elements, as serous cysts filled with different fluids, also cartilages, fibro-cartilages, and bones: all these formations frequently coexist.

§ 2335. From what precedes, it follows, as we have already remarked, that in its situation and form, the thyroid gland is a repetition, in the upper half of the body, of the uterus and prostate gland. This

(1) *Ep.* IX. *a.* 30.
(2) Haller, *El. physiol.*, vol. iii. p. 396.
(3) *Journal de médecine de Sédillot*, vol. lvii. p. 416. We there read the remarkable case of a boy fourteen years old, in whom the thyroid gland was so much swelled, without any external cause, as to produce suffocation.

analogy seems to us more just, because we frequently remark the same anomalies in both these parts at the same time in the same subject.

II. THYMUS GLAND.

A. NORMAL STATE.

§ 2336. The *thymus* gland (*Gl. thymus*, s. *corpus thymianum*)(1) is an irregular square or quadrilateral body, the base of which looks downward, and the summit upward, which occupies the upper and anterior part of the anterior mediastinum, where it is situated directly behind the sternum, before the base of the heart and the large vessels. It ascends also more or less out of the chest for about half an inch, and extends on the anterior face of the neck, where it is covered by the sterno-hyoidei and sterno-thyroidei muscles.

Its height and breadth much exceed its thickness.

Its length generally exceeds its breadth. Although it gradually contracts towards its summit, it however generally presents a more or less considerable prominence at its upper extremity.

§ 2337. Its color is reddish white, and it is soft.

Its vessels, which are not very large, arise anteriorly, enter it from above downward, from behind forward, and from before backward. But each of its lobes has not a special trunk, and receives vessels from several regions at once.

§ 2338. Beside an external envelop, which is given to it by the anterior mediastinum, the thymus gland has still a less dense or less solid proper cellular capsule, below which the fat collects here and there in corpulent persons, but does not accumulate in any great quantity.

After removing this capsule, the thymus gland is itself divided into a right and a left half. Its two lateral lobes are attached only by very loose cellular tissue, and by the vessels which penetrate them, so that it would be more correct to admit two thymus glands.

These two halves, which are also triangular, and the two internal faces, are situated one against another in their whole extent, are similar in form and volume, but are not exactly alike: one of them is sometimes about one tenth larger and heavier than the other.

The external envelop of the thymus gland will show that its surface is not smooth and uniform, but divided into several larger and smaller lobes, which are composed of smaller lobules, separated less deeply from each other, between which the two external envelops do not

(1) G. B. Metzger, *Hist. anat. med. thymi*, Tubingen, 1679.—G. H. Muller, *De glandula thymo*, Leyden, 1705.—Verheyen, *De thymo*, Leyden, 1706.—G. Bidloo, *Defens. exer., de thymo*, Leyden, 1707.—J. G. Duvernoy, in the *Comm. Petrop.*, vol. vii.—A. L. de Hugo, *De glandulis et speciatim de thymo*, Gottingen, 1746.—G. Hewson, *Experimental inquiries*, part iii. London, 1717.—Lucæ, *Anatomische Untersuchungen der Thymus in Menschen und Thieren*, Frankfort, 1811-12.

penetrate more than between the two great lateral lobes, and which are united only by a loose cellular tissue and by vessels.

§ 2339. On cutting the thymus gland, there flows out spontaneously, or by pressure, a fluid, differing from its own substance, more or less abundant, thick and whitish, similar to that which exists in the ruminantia, between the fetal and maternal portions of the placenta.

Opinions differ in regard to the relations between this liquid and the substance of the organ. With this question is connected another: Is the thymus gland hollow?

Many anatomists assert there is no cavity in the gland, and this fluid is consequently contained in its substance. Others think that the lobules alone are really hollow. Finally, some admit a great cavity the parietes of which are formed by the substance of the organ.

We maintain the latter opinion: for in examining very recent thymus glands, we have several times observed either on cutting them or slightly inflating them, a large cavity in each of the two lateral lobes. This cavity is lined by a thin and smooth membrane. It communicates with those in the lobules, and contains a great quantity of the fluid mentioned above.

Sometimes, however, this cavity is less apparent, so that very possibly the internal arrangement of the thymus gland is not always perfectly the same. Thus, in some cases, the lateral cavities are divided into several compartments by intermediate septa. Sometimes, however, we find the arrangement maintained by the partisans of the second opinion to be constant, and to which the preceding imperceptibly leads.

§ 2340. The thymus gland does not continue to exist during life.

It is first seen in the third month of gestation.

It is at first proportionally smaller than at a more advanced period, and its proportional size increases till the moment of birth.

In the full-grown fetus it weighs half an ounce, and sometimes a drachm more when the child is vigorous and strong.

Its upper part appears first, and it enlarges from above downward.

Although it is not proportionally as large until the end of the first year, and sometimes even till that of the second, it continues to grow during all this period in the same proportion as in the full grown fetus.

But at this period it wastes, its vessels contract, and the fluid it secretes diminishes. It disappears in a direction opposite to that in which it was formed, that is from below upward.

At twelve years of age we find no trace of it, and it is then replaced by fat.

From this we may conclude that it does not exist except for about the fifth part of life, and that the energy of its function declines long before it disappears. Its most flourishing period is consequently very different from that at which most other organs have attained their greatest development.

§ 2341. We have already mentioned in a general manner its functions: several circumstances lead us to think it is very intimately connected with respiration, and more or less replaces it. We may, however, easily reconcile the two conjectures, since from what we have said above, the use of the thymus gland, is to prepare for the perfect formation of the blood by respiration.

B. ABNORMAL STATE.

§ 2342. The greatest anomaly of the thymus gland is its *absence*, which is generally observed in acephalia vera.

Its *smallness*, when the organ is perfectly developed in respect to the number of its parts, is commonly attended with a languid state in nutrition generally. We have sometimes seen this anomaly also in acephalia falsa.

The thymus gland is rarely in this case divided into several, even as many as five lobes.(1)

Its continuance at the degree of development which characterizes it in the early periods of life, sometimes attends abnormal formations of the heart, and those states of the lungs which prevent the perfect formation of the blood.(2) This then supports our opinion advanced above in regard to its functions.

As this organ disappears very early, alterations in its texture are proportionally rare. We may, however, mention as such, different kinds of tumors, although in many cases those mentioned by authors are developed only in the place occupied by the thymus gland, and after it has disappeared.

CHAPTER III.

OF THE URINARY SYSTEM AND RENAL CAPSULES.

ARTICLE FIRST.

URINARY SYSTEM.

A. PERFECT STATE.

§ 2343. The *urinary organs* (*organa uropoetica*)(3) are composed of four parts destined, to secrete, carry, preserve, and excrete the urine,

(1) Meckel, *Handbuch der pathologischen Anatomie*, vol. i. p. 488.
(2) Meckel, *Abhandlungen*, p. 234.
(3) G. Bendt, *De fabrica et usu viscerum uropoeticorum*, Leyden, 1744.—J. Fantoni, *De renibus et primum de succenturiatis, de ureteribus et vesica*, Turin, 1745.—A. Richerand, *Mémoire sur l'appareil urinaire*; in the *Mém. de la soc. méd. d'émul.* vol. iv. p. 303.

viz. the *kidneys*, the *ureters*, the *bladder*, and the *urethra*. The last three organs may be opposed to the first. These are entirely excretory organs, for they carry nothing which can be useful to the organism, remove from the body an excess of azote, which is the base of the most essential constituent principle of the urine, the *urea*, and correspond in form and situation in the lower half of the body, to the respiratory organs in the upper.

I. KIDNEYS.

A. NUMBER AND SITUATION.

§ 2344. The *kidneys* (*renes*),(1) the most essential part of the urinary apparatus, are double in the normal state, a right and a left; they are entirely distinct from each other, having no communication in substance, and connected in one system only by means of the bladder. They are situated in the lumbar region, on the two sides of the vertebral column, behind the peritoneum, and are connected with the adjacent parts only by loose cellular tissue.

B. FORM.

§ 2345. They have the form of a bean. Their anterior and posterior faces are smooth. Their external and internal edges are convex in their upper and lower parts, but in their centres is a considerable depression, termed the *fissure of the kidney* (*hilus renalis*). The kidney is divided in this part for about half an inch, into an anterior and a posterior half, between which pass the excretory duct and the blood-vessels. The blood-vessels are arranged so that the venous trunk is situated before, and followed by that of the artery, behind which the ureter commences.

The branches of the renal artery and vein intercross.

When the three vessels have arrived at the fissure of the kidney, they divide near the inner edge of the gland into three principal branches, which soon ramify. The blood-vessels then divide into two series, an anterior and a posterior, which receive the vessels of the pelvis.

(1) B. Eustachi, *De renibus libellus*, Venice, 1543.—J. Lœsel, *Scrutinium renum*, Konigsberg, 1642.—M. Malpighi, *De renibus, in ex. de viscerum structura.*—L. Bellini, *De structura renum*, Florence, 1662.—Bertin, *Mémoire pour servir a l'histoire des reins*, in the *Mémoires de Paris*, 1745, p. 108.—A. Ferrein, *Sur la structure des viscères nommés glanduleux, et particuliérement sur celle des reins et du foie ;* in the *Mém. de Paris*, 1749, p. 709.—J. F. Droysen, *De renibus et capsulis renalibus*, Gottingen, 1752.—A. Schumlanski, *De structura renum*, Strasburg, 1788.—C. G. Eysenhardt, *De structura renum observationes microscopicæ*, Berlin, 1818.—A. H. C. Westrumb, *Comment. phys. de phænomenis quæ ad vias sic dictas lotii clandestinas demonstrandas referentur*, Gottingen, 1819.—Mappes, *Quelques considérations sur la structure du rein et du foie ;* in the *Journ. compl. des sc. méd.* vol. xii. p. 223.

All these vessels are united in the fissure of the kidney only by a very loose cellular tissue and by fat.

Three particularly enter and emerge through the upper part of the renal fissure, the lower part of which is occupied by the pelvis.

C. VOLUME AND WEIGHT.

§ 2346. The proportional size of the kidneys varies. Generally these organs are larger the nearer the fetus is to its period of formation: they however present, even under this point of view, individual differences, which are independent of the age, and which seem to relate to the size and energy of the other excretory organs.

Generally speaking, the two kidneys are equal in size: both, however, frequently vary extremely, although the side of the body has no effect upon it. The ancients asserted that the right kidney is always larger than the left, which is incorrect.

In the adult they are about four inches long and two broad. They are about an inch thick at their inner part, but are thinner outward.

Each of them weighs between three or four ounces.

D. CONSISTENCE AND COLOR.

§ 2347. The kidneys are much harder than the other glands, and are firmer, more solid, and less easily torn.

They are generally reddish.

E. STRUCTURE.

§ 2348. They are surrounded by a very loose cellular tissue, most generally abundantly provided with fat, and termed the *adipose membrane*, or *capsule of the kidney* (*mem.* s. *capsula renum adiposa*).

We find below this cellular mass a whitish membrane, reddish on its two faces, the texture of which is not evidently fibrous, but which is very solid, and resembles the fibrous membranes. This capsule envelops the entire kidney; it only presents an opening corresponding to the fissure, for the passage of the blood-vessels and the excretory duct, and it adheres intimately in its whole extent to the substance organ.

F. TEXTURE.

§ 2349. The kidneys are formed of two substances, which differ much in color, situation, consistence, and texture. They are the *cortical* or *glandular* substance (*substantia corticalis*, s. *glandulosa*), and the *medullary*, *tubular*, or *fibrous* substance (*s. medullaris*, *tubulosa*, s. *fibrosa*).

§ 2350. The cortical surrounds the medullary substance in most of its extent, and in every direction. It not only forms entirely the outer

face of the kidney, but extends also to its inner face by several arched prolongations, between which the medullary substance is situated. It consequently forms a collection of cavities, united by a common base, the culs-de-sac of which are turned outward.

Thus the cortical substance forms the external and colored part of the kidney; it is about two or three lines thick: its color is redder than that of the medullary substance, and it is much less consistent.

It is composed principally of blood-vessels and glandular bodies, which are the organs of the urinary passages. The urine is secreted in it.

§ 2351. The medullary substance is inclosed in the preceding, and is composed of a mass of rounded, conical, or pyramidal bodies (*pyramides malpighianæ*), the bases of which are turned outward, and the blunt summits inward; if we except the most internal part, which is only some lines high and broad, and which constitutes the *renal papillæ* (*papillæ renales*), it is entirely enveloped by medullary substance.

It opens in this place into the commencement of the ureter or pelvis.

The summit of the renal papillæ usually, but not always, presents a greater or less number of rounded openings, which although small, are visible to the naked eye. The papillæ, which have a depression, present openings only in this groove, while in those which terminate simply in a point, the foramina are arranged around the summit.

The loose extremity of these papillæ is covered by thick envelops, which is continuous with the inner membrane of the pelvis.

The number of these papillæ varies from seven to twenty. They are distributed in three series, a middle, an anterior, and a posterior, all of which are directed from above downward. Those of the inner series are turned inward towards the median line of the body: those of the anterior go backward, and those of the posterior forward, that is in a direction opposite to the preceding. The superior go downward in every direction.

Sometimes the papillæ, which are entirely distinct at their base, unite and blend at their summit.

The medullary substance is less red and much harder than the cortical.

It is composed of blood-vessels, but particularly of straight urinary passages, with which the foramina of the papillæ communicate.

The urine is secreted in it, as when it is compressed, this fluid escapes from the excretory passages which form most of it, through the foramina of the papillæ.

§ 2552. From this description it follows that the kidneys are composed of about fifteen segments, termed *lobules* (*lobuli renales*, s. *renculi*), each of which is formed in turn of medullary and of cortical substance, and the cortical envelops of which are continuous with each other.

§ 2353. The intimate structure of the kidneys is demonstrated by maceration, injection, and the microscope.

§ 2354. The surface of the cortical substance is not smooth, but seems formed by numerous irregular, rounded, quadrangular, pentagonal, or hexagonal spaces, arranged very compactly, which are not half a line in diameter. These spaces are confined by small vessels, which send branches within them: they consequently have a brighter color than that of their edges, which are formed by these vessels.

We also find in every part in the cortical substance, rounded corpuscles, appearing to the naked eye as very small points. These corpuscles depend on the most minute ramifications of the blood-vessels, particularly the arteries, and in connection with them they have the form of a bunch of grapes.

Some anatomists, especially Malpighi, Bertin, and Schumlansky, consider them as special organs, different from the branches of the vessels, as glands or bursæ, on the parietes of which the vessels are distributed. Farther, authors are not agreed in respect to them, for Bertin has described and figured them much larger than those admitted by Malpighi, while the observations of Schumlansky, from which those of Eysenhardt do not essentially differ, agree with the assertions of Malpighi. Others, as Ruysch, consider these corpuscles not as glands, but as branches of vessels.

It is more probable that they are formed by the twigs of the arteries, and by the roots of the excretory passages in the cortical substances, united by a mucous tissue, and that they are not hollow. In this manner the two opinions may be reconciled.

The urine is undoubtedly formed, at least in great part, in these corpuscles.

They seem not to have a special envelop, and they are formed, at least generally, by a single arterial twig.

They are not seen to communicate distinctly with the veins, although the transition of them to the arteries is easily perceived.

§ 2355. Besides these glandular corpuscles, the vascular ramifications to which we shall return hereafter, and finally the soft and whitish tissue which unites all these parts, and to which Ferrein particularly has called the attention of anatomists, the cortical substance also includes numerous small, white, and very tortuous canals, called the *cortical canals*, or *ducts of Ferrein* (*C. corticales*). These passages frequently anastomose together, usually proceed separately, sometimes unite in pairs, and circumscribe small and infinitely varied spaces. They compose most of the cortical substance, and are very probably the excretory canals of the corpuscles above mentioned.

These canals are tortuous in the cortical substance, but become straight in the medullary substance. When looked at attentively we observe here and there that the change in direction regularly commences rather high, some distance from the surface of the kidney, so that the cylindrical prolongations of the medullary and the cortical substance reciprocally penetrate in numerous points.

The cortical canals are single, and always have the same diameter in the cortical substance; but they gradually unite in the medullary

substance in the form of angles acute at the base, into several trunks, which generally are not much larger than they, and proceed side by side toward the summit of the papillæ; but according to some anatomists, particularly Ferrein and Eysenhardt, they do not extend to the openings in these papillæ, but terminate before arriving there. The same writers add that the openings of the papillæ only lead into small culs-de-sac about one or two lines deep, which like them are much broader than the canals of which we speak; and also fewer, there being according to Ferrein, twenty in each papilla.

We have sometimes seen very distinctly some canals which extended entirely through the renal papillæ, so that we admit a direct continuity between the urinary passages and the openings of the papillary eminences. We are more disposed to adopt this opinion, as it is very easy to inflate the passages through the papillæ, since in large animals even an injection passes from the artery into the whole papilla, and urine is pressed out from it in compressing the cortical substance.

§ 2356. Each lobule of the kidneys then is composed of several masses of canals, which are at first tortuous, then straight, arranged very compactly, which have their base turned upward, their summit downward, but represent the form of the whole, and are only more elongated.

The right part of these canals, which is contained in the medullary substance, has long been known, for it is mentioned by Berenger de Carpi; but it is described most correctly by Bellini: hence they are termed the *ducts of Bellini* (*ductus*, s. *tubuli Belliniani*, s. *renales*).

Until the time of Ferrein these canals, which are visible to the naked eye, were thought to be simple: but it follows from the researches of this anatomist and those of Schumlansky, that each is a fasciculus of several hundred passages, termed the *pyramid of Ferrein*.

Each tortuous canal is about one sixtieth of a line in diameter. The total length of all these passages collectively is, according to Ferrein's estimate, more than sixty thousand feet. There are in each lobule seven hundred pyramids, and hence as each kidney is composed of fifteen lobules, there are about ten thousand pyramids.

According to Eysenhardt's observations, each canal of the pyramids of Ferrein is composed of about twenty smaller ducts.(1)

But there is certainly much incorrectness and latitude in these assertions.

G. VESSELS.

§ 2357. The two series of vessels, after being arranged in the fissure of the kidney in the manner mentioned above, enter into the substance of the organ on a level with the base of the renal papillæ, and

(1) Eysenhardt, p 12.

go from below upward in the prolongations sent inward by the cortical substance.

Their branches describe arches turned towards one another, which principally surround the bases of the pyramids of Ferrein or the different segments of the inner substance. Between these arches the anastomoses are but few and small. Although they follow the divisions of the medullary substance they are not distributed within it, but almost exclusively in the cortical substance, first in the segments between the papillæ, then in the outer layer of the kidney.

Numerous small branches radiate from the convexity of the largest; these surround the base of each lobule, and ramify more and more to give rise finally to glandular corpuscles. Many of these branches penetrate to the external face of the kidney: others do not extend so far.

The arteries and the veins reciprocally attend each other. Still, although the direct communication between these two orders of vessels, is admitted and is easily observed, we are as yet unable to discover any between the most minute twigs of the veins and the glandular corpuscles, while these latter adhere very intimately to the ramifications of the arteries, with which they represent, as we have already mentioned, a bunch of grapes.

Numerous lymphatics arise from the kidneys, but these present nothing peculiar in the direction of their vessels.

H. NERVES.

§ 2358. The nerves of the kidney are proportionally very small; they arise from the renal plexus of the great sympathetic nerve, are situated on the surface of the arteries, but do not penetrate deeply into the organ.

II. URETER.

§ 2359. The *ureter*(1) commences at the fissure of the kidney by several rounded canals, the *calices*, which embrace the papillæ, and terminate suddenly or rather become thinner rapidly at their bases, and are continuous with their external membrane.

The number of calices generally but not always equals that of the papillæ. Sometimes a calix divided only into two compartments by a slight prominence embraces two papillæ, which are then near each other, a structure which leads to the union of two of these prolongations in one.

The others generally contract in two large trunks, a superior and an inferior, which are termed the *branches of the pelvis*. The superior

(1) Pohl, *Obs. de ureteribus*, Leipsic, 1772.

trunk is generally larger and composed of two branches. The two trunks are united by a narrower intermediate canal, which descends longitudinally.

The pelvis, which gradually terminates in a point from above downward, on a level with the lower extremity of the fissure of the kidney, is as small as the ureter.

The ureter is about two lines broad and a little tortuous; it is surrounded by a very loose cellular tissue, and descends on the psoas muscle behind the posterior wall of the peritoneum. It crosses the spermatic vessels situated before it and above the primitive iliac artery, to enter into the pelvis: it then approaches that of the opposite side, being about an inch and a half distant from it, and arrives at the lower and posterior part of the bladder. After proceeding three or four lines between the fibres of its muscular tunic, forming a prominence directed from above downward and from without inward, it opens by an orifice which is slightly narrower, having the same direction, but no valve.

§ 2360. The ureter is formed of two superimposed layers. The external is composed of a compact cellular tissue. It has a fibrous appearance, but no muscular fibres. The internal is a thin and smooth mucous membrane, which is continuous above with that of the renal papillæ, below with that of the bladder.

This canal has no valves.(1)

III. BLADDER.

§ 2361. The *bladder*(2) (*vesica urinaria*) is an elongated rounded reservoir, the length of which exceeds its breadth and thickness; it is situated in the cavity of the pelvis, behind the symphysis pubis, on the outside of the peritoneum, before the rectum in the male and the vagina in the female, and is surrounded by a very loose cellular tissue.(3)

(1) Coschwitz, *De valvulis ureterum*, Halle, 1723.

(2) J. Parsons, *Description of the human urinary bladder and the parts belonging to it*, London, 1742.—A. F. Walter, *De collo vesicæ virilis*, Leipsic, 1745.—J. Lieutaud, *Observ. anat. sur la structure de la vessie;* in the *Mém. de Paris*, 1753.—J. Van Beekhoven de Wind, *Diss. de ureteribus et vesicâ urinariâ*, Leyden, 1784.

(3) As the recto-vesical operation for stone, which becomes more advantageously known every day, requires a very exact knowledge of the anatomical relations of the bladder, we shall quote here the description of it by Sanson. (*Des moyens de parvenir à la vessie par le rectum*, Paris, 1817, p. 15.) The base of the bladder is extended from behind forward, from the recto-vesical layer of the peritoneum to the origin of the urethra, is continuous on the sides with the lateral regions of the organ, although there is no very distinct line of demarkation between them, and its dimensions are nearly equal in every direction: it is united by firm adhesions to the ureters, the vasa deferentia and the vesiculæ seminales, which passing through it obliquely from behind forward and from without inward, thus divide it into three surfaces, two of which are lateral, convex, broader anteriorly than posteriorly, situated on the outside of the seminal vesicles, and correspond to an abundant and fatty cellular tissue, which separates them from the levatores ani muscles, while the third, the central, exists between the testicles, is triangular, having a base which looks back-

We distinguish in the bladder an upper and rounded part, termed the *base* (*fundus*), a central part, the *body*, and an inferior part, the *neck* (*cervix*, s. *collum vesicæ urinariæ*).

We must regard it as an excessive common dilatation of the ureters, which curves from below upward on leaving the lower extremity of these two passages.

It is continuous at its lower extremity with the *urethra*, at the upper with the *urachus*, a kind of ligament which proceeds towards the umbilicus along the anterior wall of the anterior face of the peritoneum, gradually becoming thinner.

§ 2362. The bladder is composed in its whole extent of three superimposed layers: but in the upper part of its posterior face there are four.

The fourth layer is the most external, and covers the organ only in the place mentioned; it is the anterior part of the inferior wall of the peritoneum.

This membrane, which adheres to the subjacent muscular tunic by a very loose cellular tissue, is reflected from the bladder on the upper part of the anterior face of the uterus. The rest and largest part of the bladder is covered only by a very loose layer of cellular tissue, which unites it to the adjacent organs.

ward, and corresponds to the peritoneum, and a summit turned forward, which looks to the prostate gland and rests directly on the centre of the rectum, and follows its curve exactly to the gland. It is there separated from it, and goes obliquely from behind forward and a little from below upward to the neck of the bladder, where it blends with the origin of the urethra, which may be regarded in some measure as its continuation. This latter, the origin of which is embraced by the prostate gland and blended with the neck of the bladder, is not by any means so near the symphysis pubis as has hitherto been believed, since, placed upon a line which would extend from the lower part of this symphysis to the summit of the coccyx, it is about two inches distant from it, first passes through the prostate gland, approaching the rectum a little, then becoming loose goes directly towards the root of the penis, entering it below the arch of the pubis, from which it is about fifteen lines distant; at the same time it is about fifteen lines distant from the intestine, with which it forms an angle open towards the perineum. The skin of this region and the prolongation of the sphincter downward, the urethra forward, and the last portion of the rectum provided with this same sphincter posteriorly, form the three sides of a triangular space filled by fatty cellular tissue, the base of which corresponds to the raphe, and at the summit of which is the prostate gland. If, taking the cavity of the rectum for a point of departure, we examine the parts before the intestine in the order in which they appear, following the median line of the body, we find: 1st, on leaving the central portion, and proceeding obliquely from behind forward and from below upward, the anterior wall of this portion, a more or less dense layer of loose cellular tissue containing a net-work of small veins, the lower wall of the bladder and its cavity; 2d, on leaving the curve formed by the intestine below this region to go towards the anus, and following a more horizontal direction: the anterior wall of the rectum, a thin compact layer of cellular tissue, the prostate gland perforated by the part of the urethra where we remark the crest of the urethra and the orifices of the vasa deferentia; 3d, finally, on leaving the lowest part of the intestine, and following a horizontal line from before backward, the anterior wall of the rectum united to the sphincter, the triangular space mentioned above, and entirely forward, the bulb of the urethra and the posterior part of the bulbo-cavernosus muscle. In following this direction, proceeding from any point whatever, we open no vessels, except the capillary anastomoses which establish the communication between the two sides of the vascular system. F. T.

The texture of the muscular membrane is very complex: it may, however, generally be reduced to two superimposed layers, which, however, interlace at intervals.

The external layer, the strongest and most compact, is formed of longitudinal fibres; these fibres ascend from the lower extremity of the anterior and posterior faces of the bladder toward the base of the organ, where they partly anastomose with each other, and partly also go from within outward.

The posterior external fibres are reflected from above downward some lines below the urethra, go thence forward and upward, and are then continuous, from without inward, with the anterior longitudinal layer.

The lateral faces are mostly destitute of longitudinal fibres.

The internal layer is formed almost entirely of oblique fibres which proceed in opposite directions, so that they frequently intercross and interlace together.

The inferior are entirely transverse, and are more compact. They form the *sphincter of the bladder* (*M. sphincter vesicæ urinariæ*).

The others are more remote from each other, and represent a network, through the meshes of which we observe the inner membranes when the bladder is distended.

Below this second layer we find in several parts, but principally downward, some thinner muscular fibres arranged longitudinally, which form in this place a third layer.

§ 2363. Next to the muscular tunic come the vascular membrane, which is very thin, and the mucous membrane. The latter is apparently smooth, or at least its villosities are very minute. There are generally no muciparous glands visible on its posterior face, except at the neck of the bladder; these glands, however, may sometimes be seen when morbidly enlarged.

§ 2364. The internal face of the bladder is smooth in nearly its whole extent, except some inconstant prominences, which are often produced by the internal muscular layer.

The posterior face of the neck, however, presents an eminence which leaves the orifice of each ureter, is directed downward and inward, unites below at an obtuse angle with that of the opposite side, on the median line, and thus gives rise to an angle projecting downward, termed the *trigonus of the bladder* or *of Lieutaud.*

This eminence is formed by some fasciculi of the internal muscular fibres, which are more numerous in this part, the upper extremities of which are attached around the orifices of the ureters, and which in contracting extend and consequently enlarge these orifices, and thus facilitate the flow of urine into the bladder.(1)

(1) C. Bell, *Account of the muscles of the ureters and their effects in the irritable state of the bladder;* in the *Med. chir. trans.*, vol. iii., p. 171-191.

IV. URACHUS.

§ 2365. The *urachus*(1) is an elongated, very thin cord, which is entirely enveloped by the peritoneum ; it gradually becomes thin from below upward, is attached directly to the anterior wall of the abdominal cavity, and goes from the base of the bladder towards the umbilicus, but frequently does not extend as high. Its fibres are more or less distinctly continuous with those of the muscular membrane of the bladder.

Its texture is very differently stated by anatomists. Their descriptions vary, particularly as some admit that it is hollow in the adult, while others deny it.

Walter asserts it is hollow ;(2) Noreen, Senac,(3) and Portal, on the contrary, think it is full and solid.

The latter writers assert that this cord is composed, beside its peritoneal tunic, of four layers, intimately united at its upper part, that is, in most of its extent ; they separate near the summit of the bladder, and in passing under its muscular membrane, go, two on the sides, the other two on the anterior and posterior faces of the bladder to its neck. They add that these two layers unite with each other and with the peritoneal coat more intimately as age advances.

Walter, on the contrary, states the urachus to be formed externally by longitudinal and then by circular fibres, and after that by the vascular and muscular membranes of the bladder. We may introduce into it for some inches a sound and mercury, but it terminates at the side of the umbilicus in a cul-de-sac, and often contains a reddish fluid.

From our observations it follows that generally the urachus is completely obliterated when the body is perfectly developed, and often even long before this period, and thus it is then changed into a perfectly homogeneous cord, although we have often seen the arrangement mentioned by Walter.

Finally, Noreen and Portal themselves mention several instances of this structure, which Noreen has figured very exactly.

(1) J. C. Peyer, *Observat. circa urachum*, Leyden, 1721.—J. Noreen, *De mutatione luminum in vasis hominis nascentis, in specie de uracho*, Gottingen, 1749.—P. A. Bœhmer, *De uracho in adulto homine aperto, cum ejusd. anat. ovi hum.*, Halle, 1765. —A. Portal, *Sur la structure et sur l'usage de l'ouraque dans l'homme ;* in the *Mém. de Paris*, 1769, p. 19.

(2) *Obs. anat.*, Berlin, 1775, p. 19.

(3) *Essais de physique ;* in Portal, *Mém. sur plus. maladies*, vol. i.

V. URETHRA.

§ 2366. The *urethra*,(1) the termination of the urinary system, is a canal narrow in proportion to the bladder, which is continuous by its inner extremity, the *vesical* orifice, with the neck of the bladder, and by its outer extremity, the *cutaneous* orifice, with the common integuments. It is composed in both sexes of a mucous membrane covered with a loose and spungy cellular tissue, and a very complex vascular net-work. It is much shorter in the female than in the male, being about two inches long in the former and eight in the latter. The urethra in the female, on the contrary, is much broader than in the male.

In both sexes this canal is situated below the organs of pleasure, that is, in the female below the clitoris, and in the male below the corpus cavernosum of the penis, which latter it contributes to form.

From the different length of these parts it does not open at the same place in the two sexes. In fact in females its external orifice is situated directly before the entrance of the vagina, and between the external labia; in males at the anterior extremity of the penis. As in the male it is also the excretory canal of the semen, it will be more convenient to describe its texture when treating of the genital organs.

B. FUNCTIONS OF THE URINARY ORGANS.

§ 2367. The function of the urinary organs is to secrete and to excrete the *urine* (*urina*, *lotium*).

The physical qualities of this liquid are its yellowness, tenuity, transparence, slight viscosity, and particularly its peculiar odor.

The urine is composed of numerous constituent parts, which vary more in their proportions than number and nature, at different periods, than in any other animal liquid.

One of the principal characters of its chemical composition consists in the great quantity of water it contains, which forms at least nine tenths of it.

The substances which in the normal state are always or most generally dissolved in the water, are:

1st. *Urea*, which of all the animal substances possesses the most azote, as it contains thirty-two per cent. according to Fourcroy and Vauquelin; forty-three per cent. according to Berard; and even forty-

(1) A. Moreschi, *Commentarium de urethræ corporis glandisque structura*, Milan, 1817.—Amussat, *Remarques sur l'urèthre de l'homme et de la femme*; in the *Archiv. gén. de méd.*, vol. iv., p. 31 and 547.—E. Home, *Mém. sur la structure de l'urèthre, d'après les observations microscopiques*; same journal, vol. ii., p. 140.—T. Ducamp, *Traité des rétentions d'urine*, Paris, 1822, p. 1.

six per cent. according to Prout, while there is only about twenty per cent. in the fibrine.

2d. An animal substance insoluble in alcohol.

3d. Several acids, the uric(1) and the lactic.

4th. Several salts, viz. the lactate of ammonia, sulphate of potash, sulphate of soda, phosphate of soda, hydrochlorate of ammonia, and the earthy phosphates, with some fluate of lime.

5th. A little of silex.(2)

Besides these substances, which enter regularly into the urine, we sometimes recognize by our senses several constituent principles of the body introduced into the system in different modes. Thus, for instance, rhubarb colors it a deep yellow, and asparagus communicates to it a disagreeable odor.

Although these substances also occur in greater or less quantity in the other excretory fluids, especially in those exhaled by the lungs and the skin, and in the matters expelled directly from the intestinal canal, they nevertheless occur more frequently in the urine, so that the urinary system seems to be the principal excretory organ of those materials which cannot be assimilated. It necessarily exercises a peculiar attraction for these substances, in order to remove them from the blood and fulfill its function.

This system is also the principal agent of purifying it in the morbid state: thus the urine is more or less modified in all diseases generally.

§ 2368. But the urine constantly presents differences also in regard to the greater or less length of time which has elapsed between its emission and taking food or drink. Upon this is founded the distinction between the *urine of the drink*, and the *urine of digestion* or *of the blood*. But it must be admitted that these differences are very slight.

The urine of the drink, which is voided directly after a meal, is very watery and limpid. The urine of digestion, voided some hours after eating, during the digestive process, is more colored, less watery, more odorous, and usually presents the smell and taste of some of the articles of food. Finally, that which is passed when digestion is finished, the proper and perfect urine, is more highly colored, and less in quantity: it has not the characters of the ingesta, but on the contrary, presents the characteristic smell and taste of the urine.

From comparative experiments, the urine of the food contains only one thirteenth of urea, one sixteenth of uric acid, and one fourth of the salts found in the urine of digestion or of the blood.

§ 2469. For a long time the question has been discussed, and it is not yet settled, whether the constituent materials of the urine are

(1) It seems probable, from Prout's experiments, that pure uric acid does not exist in the urine, but it is combined with ammonia. Lactic acid is then the only cause of the acidity of the urine in the normal state. F. T.

(2) Berzelius, *Annales de chimie*, vol. lxxxix., p. 22.

carried to the urinary system only by the vascular system, or whether they do not proceed there directly by a shorter route, and consequently, whether there are not *secret urinary passages* (*viæ urinariæ clandestinæ*).

The arguments in favor of the existence of these passages, are :(1)

1st. The rapidity with which fluids, especially cold water, are expelled with the urine, and particularly the great quantity of fluids evacuated in a short time through this passage, whether these liquids have been introduced into the intestinal canal, or injected into the cavity of the abdomen.

2d. The passage of several substances through the urine unchanged, instances of which we mentioned above.

3d. The presence in the urine or in the lymphatic vessels between the mesentery and the urinary system, of these substances, or of other materials formed even in the body, as the saccharine matter in diabetes, although the blood contains no trace of them.

4th. The presence of urine in the bladder, although the kidneys have been destroyed, the ureters tied, and even when the kidneys did not exist, or at least they did not communicate with the ureters.

5th. The presence in the bladder of solid bodies introduced into the body by swallowing or any other mode.

6th. The very active sympathy between the bladder and the stomach.

The manner in which the substances contained in the urine can arrive at the urinary system without passing through the vessels, has been explained in several different ways.

1st. Some think there are no visible channels, but that the phenomena depend simply on transudation through the adjacent parts, particularly from the intestinal canal into the bladder, through the medium of the mucous tissue.(2)

2d. Others admit a retrograde motion in the lymphatic vessels and urinary system, and even support their opinion by those cases where the valves of these vessels have an opposite direction, and are turned from the heart.

3d. Finally, some admit special canals, situated between the stomach and the urinary apparatus.

§ 2370. But it is easy to refute all these arguments and the manner in which they are explained.(3)

(1) C. G. Kratzenstein, *Theoria fluxus diabetici ejusque sanandi methodus*, Halle, 1746.—Darwin, *Zoonomie*, vol. i.—Wollaston, in the *Phil. trans.* 1811.—Treviranus, *Biologie*, vol. iv. p. 513-521.—Morichini, in the *Mem. della soc. ital.*, vol. xvii.–Tiedemann and Gmelin, *Recherches sur la route que prennent diverses substances pour passer de l'estomac el du canal intestinal dans le sang, sur la fonction de la rate et sur les voies cachées de l'urine*, Paris, 1821.

(2) Treviranus, *Biologie*, vol. iv. p. 513-521.

(3) P. J. Hartmenn, *Super urinæ diâpedes quæstiones*, Utrecht, 1776.—G. G. Erhardt, *De secretione lotii unica et sufficiente*, Erfort, 1799.—J. Jacopi, *Esame della dottrina di Darwin sul moto rctrogrado dei liquidi nei vasi linfatici*, Pavia, 1804.

Nothing can be concluded from the last two arguments, for the sympathy between the stomach and the urinary system does not depend on mechanical connections between them, and solid bodies penetrate through unusual channels formed by these bodies from the compression they exercise.

In order to refute the fourth argument, it is sufficient to remark that we do not in fact find urine in the bladder when the kidneys have been entirely destroyed, that a portion of the kidney still remains where they seem to have been entirely destroyed, that no urine collects in the bladder after tying the ureters, if the bladder be entirely emptied; and finally, that the cases of a noncommunication between the ureters and the kidneys are very doubtful.

To the third argument we may answer, that at least all the immediate principles of the animal substances do not exist in the blood; those found there do not exactly resemble those in the body, since the same substances occur in other parts of the body, from whence it is not proved that they pass into the urinary system: that very possibly the substances proved to exist in the urine, might have disappeared from the blood or were concealed in some mode: that these substances have not been looked for in the arterial, but in the venous blood: finally, that according to Magendie, we may prove the existence of one of these substances, the hydrocyanate of potass, in the urine, in any quantity however small, while after mixing it with the blood, even out of the body, we cannot detect it, even when in great quantity, by chemical reagents.

Besides the simultaneous existence of several substances, as rhubarb, has been proved in the serum of the blood and the urine.(1)

Treviranus asserts(2) that this phenomenon proves nothing, as the serum of the blood contained less rhubarb than the urine. But it is easy to refute this objection, as the rhubarb is distributed through the whole mass of the serum, and could only be removed from it by the urinary system.

The lymphatic vessels, situated near the mesentery, may either have sent these substances into the urinary system, and have accidentally imparted to them a retrograde motion, contrary to that which the fluids generally follow, although we have no right to conclude that foreign substances always enter the urinary system through this channel, nor even by admitting the retrogade motion, that they were introduced by it.

The facts alledged in support of the second argument, do not contribute in manner to the explanation given of them. The formation and the want of decomposition in certain substances would not be explained more easily by this theory: for even admitting this channel, which is not much shorter, they are no less subject to the organic action: but Davy's observations prove, that under the influence of

(1) Home, in the *Phil. trans.*, 1808.
(2) *Biologie*, vol. iv. p. 520.

electricity, bodies may be separated contrary to the laws of chemical affinity, and carried far by the fluids, without combining with other substances which these fluids contain, and which have great affinity for them.

Finally, in regard to the first argument, the rapidity with which drinks and certain substances pass into the urinary system, is not in fact as great as has been asserted, and may be easily explained by the short distance they proceed, even admitting that they are carried there by the blood.

If we find rhubarb in the urine in seventeen minutes, if it disappears from this liquid at the end of some hours, if it colors the excrement after six or seven hours, and is then found again in the urine, this fact does not prove as Treviranus asserts,(1) that the rhubarb first found, has arrived at the urinary system by a shorter route than that afterward observed.

The rhubarb which appears first in the urine, has undoubtedly passed from the stomach, to the inner and absorbing face of which it was presented, without being decomposed into the sanguineous system, and seventeen minutes is not too short for the latter to come to the urinary system. The action of the rhubarb on the inner face of the stomach and intestinal canal, gradually causes the mucous membrane of these organs to a greater secretion, which surrounds them on every part and diminishes absorption. When this excessive action abates, the rhubarb is again absorbed. But there is another cause to which we must probably attribute the disappearance of the rhubarb in the urine during a certain length of time, viz. that the action of the kidneys is less energetic, while that of the alimentary canal is increased.

§ 2371. In regard to the passages, we may say:

1st. The opinion that the cellular tissue serves as a conductor, is very improbable, first, because the application of phenomena observed in the inferior animals, to the theory of those which occur in the superior animals, leads only to uncertain results, since by admitting this supposition, it is difficult to explain why the passage takes place through the kidneys.

2d. The retrograde motion in the lymphatic vessels is very improbable, at least in the normal state, on account of the existence of valves. The cases where it is asserted the valves were found arranged contrary to what they are generally, are only exceptions, or at least are not sufficiently proved. Farther, this arrangement could not be general, since then there could be no absorption from the bladder. It is not proved that these valves are arranged in one manner in certain lymphatics, and an opposite manner in others.

3d. The special canals have never been proved by authentic observations, and the passages considered as such, were evidently accidental and morbid formations.

(1) *Biologie*, vol. iv. p. 519.

4th. Finally, another circumstance prevents its admission, viz., that we have never found between the digestive canal and the urinary passages, any substance in these two systems not contanied in the sanguineous system, and even when this phenomenon occurs, it can always be explained by saying that the substances in this place, especially in the lymphatic vessels, have come there from the urinary system.

C. SEXUAL DIFFERENCES.

§ 2372. The urinary system, except the bladder and the urethra, presents no considerable differences relative to sex.

The bladder is rounder, broader, and generally larger in the female than in the male, where it is more elongated.

The urethra of the female is broader and shorter than that of the male, representing in fact only its commencement.

D. DIFFERENCES DEPENDENT ON DEVELOPMENT.

§ 2373. This system changes much during life, in form, texture, proportional size, and situation.

I. KIDNEYS.

§ 2374. 1st. The kidneys are much larger proportionally the younger the fetus is: in the full-grown fetus their weight is to that of the whole body as 1 : 80, while the proportion in the adult is as 1 : 240.

2d. In respect to form they are more elongated, and the pelvis is nearer the anterior face, so that the renal fissure is less developed. Their surface is not smooth; they do not form a coherent and homogeneous mass, but are composed of several lobules, which are at first distinct, but are united so as to produce the larger lobes, which are very evident in the adult, where, however, they are not separated. At this period of life, in fact, they are attached only by a very loose cellular tissue, so that they are easily insulated, and their bases are even marked on the surface of the kidney by considerable depressions.

3d. The medullary substance is more abundant in proportion to the cortical substance, than in the adult, at least in the full grown fetus. The fasciculi of the urinary passages, or the pyramids of Ferrein, are separated from one another more easily, and like all parts of the body, are evidently composed of globules, which are not seen in the adult: on the contrary, the passages are more difficult to be distinguished. Here then, also, as in the muscles and the lungs, the large parts are formed before the small.

II. URETERS.

§ 2375. The ureters are also broader, proportionally, than when the subject is perfectly developed.

III. BLADDER.

§ 2376. From the narrowness of the pelvis, the bladder is not contained in this cavity ; it is then situated much higher than in the adult, so that the urethra is proportionally very much longer.

It is much smaller before than after birth.

Its form is more elongated. This circumstance and its smallness, cause it to appear as a simple filament, and it seems to be only a slight dilatation of the urachus.

IV. URACHUS.

§ 2377. The urachus is much larger the younger the person is ; it gradually diminishes, until in the course of life it often entirely disappears.

It is at first hollow, and according to our observations, it retains this character in the full-grown fetus. At this period we can distinguish in it all the constituent membranes of the bladder with which its cavity communicates. This cavity is at first much larger proportionally, the younger the fetus is. In the full-grown fetus, and still more at the periods preceding birth, we can follow the urachus a greater or less distance, but always several inches beyond the opening of the umbilicus, sometimes even the whole extent of the cord. Analogy with animals, and several observations upon man, authorize us to think that it passes at first entirely through the umbilical cord, and dilates between the envelops of the fetus, to give origin to a membranous vesicle, the *allantosi*, to which we shall return when describing the human ovum. This cord is certainly hollow, for even in the full-grown fetus we have injected it with mercury through the bladder, and the injection extended more or less in the umbilical cord. Our observations on this subject agree with those of Rœderer(1) and Noreen.(2)

Several of the ancient anatomists, and even Trew, among the moderns,(3) have admitted that the urachus is full and solid in the fetus, as it normally is in the adult. This erroneous opinion depends upon a great inflexion in the canal near its lower extremity ; hence, when the bladder is distended, the muscular fibres are so adapted to its sides, that the opening by which they communicate is closed.

(1) *De fœtu perfecto*, Halle, 1759.
(2) *Loc. cit.*, p. 13.
(3) *De diff. inter. hom. natum et nascendum*, p. 104.

ARTICLE SECOND.

URINARY SYSTEM IN THE ABNORMAL STATE.

§ 2378. The urinary system is one of those anomalies which occur most frequently,(1) particularly as respects those of formation, for the most striking differences it presents, relate to the form, situation, and size of its different component parts, and also to its vessels. Besides, its cavity not unfrequently includes foreign bodies, which depend particularly on alterations in the chemical composition of the urine.

DEVIATIONS OF FORMATION.

A. KIDNEYS.

§ 2379. The primitive deviations of formation in the kidneys,(2) which depend more or less evidently on a suspension of development,(3) are:

1st. The *absence* of one or both of them.

2d. *Smallness*, in which case when this anomaly occurs on one side only it is frequently, but not always, made up by the greater size of the kidney of the other side.

3d. The greater or less difference in the size of the two kidneys.

4th. The great size of these two organs.

5th. Their union in one only. This anomaly differs much in degree and quality.

The differences in respect to quality principally affect their situation. Sometimes there is no trace indicating that a kidney has ever existed in the place where it is not found; the single kidney occupies the usual place, follows the normal direction, and we discover that it is formed by the union of the two, not only because it is larger than in the normal state, but also because it is contracted at its centre, from the excess in the number of its vessels, its fissure, pelvis, and ureter. Sometimes the two halves of the single kidney are situated each in the usual place.

As to the differences in degree, the two kidneys are generally united only at their lower part and to a greater or less extent, so that they

(1) Baillie, *Engravings*, London, 812, fasc. vi-viii.—C. Bell, *Engravings from specimens of morbid parts, preserved in the authors collection selected from the division inscribed urethra, vesica, renes, morbosa et læsa*, &c. London, 1813.—J. Howship, *Practical observations on the diseases of the urinary organs, particularly those of the bladder, prostate, gland, and urethra*, London, 1816.

(2) O. Heer, *De renum morbis*, Halle, 1790.

(3) See in respect to these deviations of formation, our *Handbuch der pathologischen Anatomie*, vol. i. p. 610.

form a semicircular mass, which is concave upward and convex downward. The union extends more rarely to their whole height, in which case they are changed into a rounded or square mass.

6th. They are more oblong than usual.

7th. The situation of the pelvis on the anterior face. These two anomalies generally attend enlargement, but they sometimes occur also although there is no mark of hypertrophy.

8th. The lobular structure, which sometimes gives rise to several separate kidneys.

Their low situation, so that sometimes we find the two kidneys in the pelvis.

§ 2380. Several of these anomalies are developed also during life only, as is true of abnormal enlargement and diminution. Not unfrequently, in fact, the kidneys enlarge sometimes to an enormous extent, although they change their texture, or on the contrary they disappear and are almost entirely effaced.

In the latter case sometimes they diminish much in volume, but their mass continues solid, or they even preserve their size or enlarge, but their substance is almost wholly destroyed, and they are changed into a sac with thin parietes. Wasting of the first kind supervenes after a disease of the organ; but not so with the second, which often depends on an obstacle to the escape of the urine which exists below the kidneys.

B. URETERS.

§ 2381. The deviations in the form of the ureter are particularly worthy of notice.

Their congenital anomalies are:

1st. Their *absence.*

2d. Their *imperforation* in one or several points, from an obstacle.

3d. Their *plurality*, occurring from the want of union of the branches of the pelvis; this exists in different degrees.(1)

The most common consecutive deviation of formation is their abnormal dilatation or distension from an obstacle to the course of the urine situated in the ureter, or in another portion of the urinary system, or even out of it. Obstacles of the first kind are calculi and contractions; those of the second are the engorgement of the glands of the pelvis, the swelling of the internal genital organs, the adhesions of these parts either with each other or with the adjacent organs, &c.

Finally, the ureter is sometimes ruptured from excessive distension.

(1) Meckel, *Handbuch der pathologischen Anatomie*, vol. i., p. 715.

C. BLADDER.

§ 2382. The primitive deviations in the form of the bladder are:

1st. Its *absence*, attended or not with that of the rest of the urinary system.

2d. Its *smallness*.

3d. Its *fissure*. This anomaly is not very rare, and is termed the *prolapsus of the bladder*(1) (*prolapsus vesicæ urinariæ inversæ*). Its principal characters are:

At the lower extremity of the anterior face of the abdomen, above the symphysis pubis, is a reddish, soft, rounded place, the edges of which are continuous with the common integuments, and at the base of which are two mammillary eminences directed one towards the other, whence urine continually dribbles. It is the bladder in the form not of a pouch but a layer, the anterior face of which is formed by its mucous membrane.

Behind this membrane is the muscular tunic, covered at its upper part by the peritoneum. The eminences are the orifices of the ureters situated in the usual place, and which are not generally abnormal, except from their great breadth.

The umbilicus is situated directly above the upper extremity of the bladder, and consequently much lower than usual.

The urethra then most generally opens above the penis in the male, and the clitoris in the female: it is more or less cleft, and more or less imperfectly developed. Considered generally, the external genital organs seem to have separated from each other to the right and left.

Excepting at most two cases as yet published, the symphysis pubis is always more or less imperfectly closed, on which depends the apparent shortness of the penis.

Duncan(2) asserts that this anomaly belongs particularly to males: but the number of cases of its occurrence in females, mentioned by this author, may be much enlarged.

4th. The *bifurcation* of the bladder, or its formation by several connected sacs.(3)

5th. The continuance of the urachus to the umbilicus, through which the urine then escapes.

§ 2383. The following anomalies are, at least commonly, consecutive or accidental.

1st. Excessive size. Here there is sometimes simple dilatation, and sometimes an increase in mass and volume. This anomaly generally depends on an obstacle to the course of the urine, situated at the lower part of the bladder or in the urethra.

(1) Meckel, *loc. cit.*
(2) *Edinb. med. and surg. journal*, 1805.
(3) J. A. Ehrlich, *Chirurgische Beobachtungen*, vol. ii., Leipsic, 1815, p. 123.

2d. The considerable development of the muscular tunic, which sometimes occurs without dilatation, or even when the bladder is unusually small, which depends particularly on the presence of a foreign body, as a calculus, in the bladder.

3d. *Hernias* of the inner membrane of the bladder through the muscular tunic (*appendices*, s. *processus*),(1) which are very rarely congenital, and commonly arise from the same cause as the preceding.

4th. *Ruptures* of the bladder, which are generally caused by its excessive distension.

5th. *Displacements, hernias* of the bladder. The bladder most generally projects at the base, and gives rise to *vaginal hernia* when it rests on the vagina, either because it has become very heavy, as in the cases where it is filled by a calculus, or because it is depressed by the contraction of the space it occupies, as in pregnancy. It then causes a more or less perfect inversion of the vagina, after which it is itself precipitated more or less, especially when the inversion is congenital.

We also find the bladder in inguinal hernias, but much more rarely.(2)

6th. When the bladder and vagina fall rapidly, there is sometimes an inversion of the bladder. The urethra is necessarily more or less torn, in order that this accident should supervene.

II. ALTERATIONS OF TEXTURE.

A. KIDNEYS.

§ 2384. The two kidneys do not always possess the same consistence. They are sometimes very flabby in persons affected with diabetes, in which case they frequently receive more blood than usual.

On the other hand they are sometimes unusually firm.

They are not unfrequently changed into fat.

Frequently also a great number of serous cysts are developed in these glands in old persons; these generally adhere, are filled with a differently colored and generally a limpid serum, which sometimes entirely destroys their substance. In some cases the kidney seems formed primitively of similar cysts.(3)

Scrofulous(4) and spungy tumors occur more rarely in the kidneys.

(1) Brocke, *De vesica urinariæ appendicibus*, Strasburg, 1754.—C. Bell, *Surgical observations*, pt. iv., London, 1817.
(2) Meckel, *Handbuch der pathologischen Anatomie*, vol. ii., p. 424.
(3) O. Heer, *De renum morbis*, Halle, 1790, tab. i.
(4) Baillie, *Engravings*, fasc. iv., tab. viii.

B. BLADDER.

§ 2385. When the bladder enlarges, its membranes are also generally thickened by inflammation, become firmer, adhere more to each other, or are destroyed in parts.

The muciparous glands of the inner membrane are often enlarged in catarrh of the bladder.

Irregular, rounded, reddish tumors of various sizes are developed on this membrane, principally at the lower part of the posterior wall of the bladder; these rest upon a narrower base, and have no determinate texture. These tumors, called *funguses of the bladder* (*fongus vesicæ urinariæ*), are observed principally in males, and at an advanced age.

III. FOREIGN BODIES.

§ 2386. Of the foreign bodies most frequent in the urinary system, and consequently in the ureters and bladder, entozoaries are rare, and calculous concretions are very frequent.

A. ENTOZOARIES.

§ 2387. The entozoaries in the urinary system are:

1st. Hydatids,(1) which occur particularly in the kidneys, and perhaps are always primitively developed there.

2d. The *strongylus gigas*, which exists in the kidneys.

3d. Two other worms, as yet undetermined, which were voided with the urine.(2)

B. CALCULI.

§ 2388. The *urinary calculi*(3) present several general and special important characters.

(1) Baillie, *loc. cit.*, tab. vii-viii.

(2) Lawrence, *Case of a woman who voided a large number of worms by the urethra;* in the *Med. chir. trans.*, vol. ii.

(3) Tenon, *Sur la nature des calculs;* in the *Mém. de Paris*, 1765.—Scheele, *Untersuchung des Blasenstcins;* in the *Schwedische Abhandlungen*, vol. xxxvii.—E. Sandifort, *De calculo renal.;* in the *Obs. anat. pathol.*, 1777, vol. i., p. 6; *De calculis renum et vesicæ*, ibid., vol. iv., p. 7; *De lcthali urinæ suppressione ex calculo urethræ inserto, indeque natâ duplici hujus canalis rupturâ;* ibid., vol. iii., p. 3.—F. A. Walter, *Anatomisches Muscum*, th. i., Berlin, 1796.—Wollaston, *On gouty and urinary concretions;* in the *Phil. trans.*, 1797.—Pearson, ibid., 1798.—Fourcroy, in the *Annales du Museum*, vol. i.—Brande, in the *Phil. trans.*, 1808.—Magendie, *Recherches sur la gravelle*, Paris, 1818.—Prout, *An inquiry into the nature and treatment of biabetes, calculus, and other affections of the urinary organs, with notes and additions, by* S Colhoun, M. D., Philadelphia, 1826.—Marcet, *Essai sur les affections calculeuses*, Paris, 1823.—F. A. G. Hoffmeister, *De calculis urinariis collectanea quædám*, Leipsic, 1821.

§ 2389. Their general characters relate to their situation, texture, form, volume, number, mode of development, and effect on the organs which contain them.

1st. *Situation.* It varies both in itself, and in its relations with the urinary system.

a. Calculi occur in the cavity or in the parietes of this system.

The calculous concretions in the first are much more common than in the second.

Of the four parts in which they can be developed, the pelvis, the ureter, the bladder, and the urethra, they occur most frequently in the bladder, and most rarely in the urethra.(1)

The portion of the cavity of the urinary system which contains them, particularly of the bladder, is not generally separated from the rest by an abnormal septum. Sometimes, however, the calculi are inclosed in a special sac, which communicates with the common cavity by a narrow opening; they are then termed *encysted calculi.*

This state is doubtless in most cases the source of the calculi existing in the parietes of the bladder. We must admit that the communication at first existing is finally obliterated; it is impossible to suppose that the concretions were formed except within the cavity of the bladder.

b. Most generally, and even most always, the urinary calculi are entirely loose; but sometimes they are attached to the inner face of the bladder by mucus or thickened and coagulated fibrine, which exists between their prominences.(2)

2d. *Texture.* The urinary calculi are generally formed of superimposed layers, more or less distinct and more or less concentric. Their centre also is usually formed by a nucleus, which most generally consists of a small mass of uric acid, more rarely of a foreign body accidentally introduced into the urinary apparatus, particularly the bladder.

The different layers are generally, but not always, similar in their chemical composition. They are always formed of at least two substances, one solid, the other softer and originally fluid, which unites and connects the particles of the preceding.

3d. *Form.* The urinary calculi are more or less oblong and rounded, and generally smooth and a little flattened. This character depends in great part on the influence of the organ which contains them, the bladder being round. The form of the renal calculi demonstrates particularly the great influence of the form of the organ on that of these concretions.

(1) Ehrlich has described a very remarkable renal calculus. (*Loc. cit.*, vol. ii., p. 24.)

(2) Meckel, *Handbuch der pathologischen Anatomie*, vol. ii., pt. ii., p. 444.—Howship, *loc. cit.*, p. 249, tab. iii., fig. 5.—Bell, *Surgical observations*, London, 1818, pt. iv., p. 444, tab. i.

4th. *Volume.* The size of the calculi varies from that of an almost invisible grain to a diameter of several inches; they are sometimes so large that they completely fill the bladder, and even distend it.

5th. *Number.* Usually there is only one, or there are but few. When many exist their chemical composition is generally, but not always, the same.

6th. *Mode of development.* We may mention, as a general rule, that the formation of the calculi depends either on the abnormal state of the urinary system, or on the presence of a foreign body accidentally introduced into the bladder.

The abnormal state of the urinary system may vary in several different modes. The secretory portion is generally affected, so that an alteration in the chemical composition of the urine is most generally the cause of the formation of calculi. This accidental production depends more rarely on an abnormal arrangement in the bladder, or the excretory portion of the urinary system. It may, however, be caused by a mechanical obstacle to the emission of the urine, especially by sacs in the parietes of the bladder, by the hernia of the bladder, or by strictures of the urethra. Calculi have even been developed between the glans and the prepuce.(1)

7th. *Influence on the urinary system.* This influence varies. Whenever they are developed, the urinary calculi, being foreign bodies, cause more or less acute pains, the intensity and nature of which depend on their form, situation, number, and size, independent of the degree of sensibility of the patient.

The changes caused by them in the form of the urinary system are, the distension of the membranous parts, particularly the ureters, the thickening of the muscular portion, consequently of the bladder, which often attends their enlargement, but still more frequently the contraction of its cavity, finally rupture, which is more rare, and which occurs particularly in the urethra.

§ 2390. The peculiar characters of the urinary calculi relate principally and almost exclusively to their chemical composition.

Chemical analysis has discovered in them at this date uric acid, the phosphate of lime, the ammoniaco-magnesian phosphate, the oxalate of lime, and the cystic oxyd. There have been found also, but more rarely, less constantly, and in less quantity, silex, carbonate of lime, iron, and two other peculiar substances, the xanthic oxyd, and a fibrinous substance. Wollaston and Brande doubt the presence of urate of ammonia, admitted by Fourcroy and Vauquelin, and consider this salt as produced by the chemical analysis; but we cannot conclude positively from the arguments with which their opinion is supported that it never occurs in common calculi.

(1) Walter, *Obs. anat.*, Berlin, 1775, p. 74.—Penada, in Brera.—Meckel, *Handbuch der pathologischen Anatomie*, vol. ii., pt. ii., p. 444.

Sometimes these substances are distinct, and sometimes they combine in a greater or less number to form a concretion, whence numerous kinds of calculi are formed.

The simple calculi are:

1st. Those of uric acid, which are smooth, of a brownish red, and generally composed of concentric layers. They are the most common.

2d. Those of phosphate of lime, which are proportionally rare, are white, and composed of layers easily separated.

3d. Those of oxalate of lime are round, generally rough and brown; sometimes they are smooth, and seem to form always in the kidneys.

4th. Those of the cystic oxyd, more properly the renal oxyd, because this substance is very probably developed in the kidneys. These calculi are yellowish and semitransparent. They have no lamellar texture.

5th. Those of xanthic oxyd, which have been seen only once.

6th. Those of fibrinous matter, which also have been seen only once.

The calculi composed of different substances which do not form as many separate layers are:

1st. Those of the ammoniaco-magnesian phosphate, or the *fusible calculi* (*calculus fusibilis*) of Wollaston and Marcet, the most common next to those of the uric acid. They are white, and more friable than those of the other species. The ammoniaco-magnesian phosphate often predominates, although it seldom or never forms it alone. The calculi formed around the foreign bodies introduced into the bladder, those developed in ischuria, or between the prepuce and the glans, are most generally of this nature, because in this case the urine is more or less decomposed.

2d. The more complex calculi are distinguished by their indeterminate form, their color, their structure, which is not evidently in strata, and their hardness.

Finally, among the compound calculi, there are some in which the different layers are formed by as many distinct substances. The number of these substances varies from two to four: but there are generally but two, the uric acid, with a phosphate or oxalate of lime, with sometimes another phosphate, or with silex. In a calculus formed by four layers, Marcet has found, from the centre to the circumference, cystic oxyd, phosphate of lime, oxalate of lime, and the ammoniaco-magnesian-phosphate.

ARTICLE THIRD.

RENAL CAPSULES.

I. NORMAL STATE.

A. SITUATION.

§ 2391. The *renal capsules* (*renes succenturiati*, *capsulæ*, s. *glandulæ suprarenales*, s. *atrabiliares*),(1) are triangular bodies, very flat from before backward, resting directly on the kidneys, to which they are united by a short cellular tissue. They occupy their upper extremity and the upper part of their internal edge. Like them, they are situated on the outside of the peritoneum.

B. FORM AND VOLUME.

§ 2392. We have mentioned the general form of the renal capsules. They are more long than broad, that is, they extend farther from above downward than from right to left. They are only about one line thick. Their form differs on the two sides: that of the left side is a little higher and narrower than that of the right: the left is from fifteen to seventeen lines long, and about three broad: the right is generally from fourteen to fifteen lines long, and twelve or fourteen broad.

We remark on their external face the fissures through which the blood-vessels enter and depart. The left capsule usually presents forward a longitudinal fissure, while there are two on the right side, an anterior and a posterior.

C. WEIGHT.

§ 2393. Each renal capsule in the adult weighs about one drachm.

D. CONSISTENCE AND COLOR.

§ 2394. These organs are quite firm but brittle. Their color is yellowish brown externally, and a deep reddish brown internally.

(1) A. M. Valsalva, *Diss. anat.*, *III.*—B. Morgagni, *Epist. anat. XX.*—Duvernoy, *Comm. Petrop.*, vol. ii.—Bœckler, *De thyroïdæ, thymi et glandularum suprarenalium functionibus*, Strasburg, 1753.—J. C. Mayer, *De glandulis suprarenalibus*, Frankfort, 1784.—Riegels, *De usu glandularum superrenalium necnon de origine adipis*, Copenhagen, 1790.—F. F. Leonhardi, *Diss. de glandulis suprarenalibus*, Dresden, 1810.—J. F. Meckel, *Abhandlungen*, p. 1–277.

E. TEXTURE.

§ 2395. They are composed of two substances, one external, more consistent and yellowish, the other internal, softer and of a deeper brownish red. The first is evidently formed of perpendicular fibres, which are directed from without inward. These two substances are often intermixed, whence the capsule appears spotted externally. The external is divided more or less easily into rounded lobes, which may themselves be divided into lobules, and it is covered by a very thin serous membrane, which intimately adheres to its surface.

According to several anatomists, the renal capsules contain a more or less complex cavity. However, after much research, we are obliged to adopt the opposite opinion;(1) we think that there is normally no cavity, that it does not form till after death, and that it results either from the spontaneous decomposition of the inner substance, which is not very consistent, or from this substance being destroyed by handling it.

The substance of the renal capsules, particularly the internal, is very intimately and directly connected with the veins, for the liquids and air injected into these vessels easily penetrate them, and the air often forms in them a cavity, they are so soft.

§ 2396. The renal capsules are imperfect glands, as they have no excretory ducts. In fact, these ducts have been admitted by some anatomists of note, as Bartholini,(2) Peyer,(3) Valsalva,(4) Ranby,(5) Kulmus,(6) Heuermann,(7) and Bendt.(8) The capsules communicate with the testicles, according to Bartholini, Peyer, Valsalva, and Ranby: with the thoracic canal according to Kulmus, with the pelves of the kidneys according to Heuermann and Bendt. But very careful and numerous dissections have led us to the contrary opinion. The absence of an excretory duct in these organs seems more probable, as it accords with the researches of Morgagni.

II. DIFFERENCES PECULIAR TO THE RACES.

§ 2397. Some writers have asserted that the renal capsules were larger in negroes than in the Caucasian race, and that their medullary substance was darker.(9) We have seen nothing of this in dissecting a negro, although we had previously observed it in a negress.(10)

(1) See our *Abhandlungen*, p. 17.
(2) Rhodii, *Mantissa*, p. 36.
(3) *Obs. anat.*; obs. 32.
(4) *Diss. anat., III.* Morgagni, *Ep. an. XX.*
(5) *Phil. trans.*, p. 385.
(6) *Bresl. Samml.* 1722, Feb.
(7) *Physiologie*, vol. iv. p. 97.
(8) *Defabric. visc. uropœt.*, p. 17.
(9) Cassan, *Observ. med.*; in Hufeland, *Annalen der franzœsischen Arzneywissenschaft*, vol. i. p. 475.
(10) *Handbuch der pathologischen Anatomie*, vol. i. p. 648.

III. DIFFERENCES DEPENDENT ON DEVELOPMENT.

§ 2398. The renal capsules are very easily distinguished in the fetus of two months.

Their proportional size gradually diminishes on their first appearance, and the same is true, at least frequently, of their absolute size after birth. They become thinner and dryer, wrinkle, and even entirely disappear in old age.(1) At the end of the third month they are a little larger and heavier than the kidneys: at four months they are equal in size to these glands, but they are lighter, because their tissue is looser. At the commencement of the sixth month they are only half as large as the kidneys, but their weight is to that of these latter as 2 : 5, since each capsule weighs ten grains, and each kidney twenty-five. In the full-grown fetus the proportion is about as 1 : 3, each capsule usually weighs a little more than four scruples, and each kidney more than half an ounce. In the adult, on the contrary, the relation is as 1 : 23, for the capsule weighs one drachm, and the kidney three and a half ounces.

These organs are composed of lobes, which are at first more numerous and more distinct than in the adult; but they do not always contain a cavity in the early periods of life.

IV. FUNCTION.

§ 2399. It is very difficult to mention the function of the renal capsules, although their great size before birth indicates their importance.

We have every reason to think, that like the liver, the spleen, the thyroid, and the thymus glands, they contribute directly to the perfect formation of the blood. Their great size in the fetus, their free communication with the venous system, and their nearness to the ascending vena-cava, are at least so many circumstances in favor of this conjecture.

Those observers who admit an excretory duct to the genital organs, necessarily connect the renal capsules directly with them. Other facts, particularly their simultaneous, considerable development in several orders of the mammalia had suggested the same idea to us,(2) before we knew that it belonged to another, but we could not describe the mode in which the renal capsules and the genital organs co-operated.

We may also mention in support of this hypothesis, the coincidence of anomalies in the renal capsules with those in the genital organs. Thus, Vauquelin has found the capsules ossified in a cat, from which the ovaries had been extirpated.(3) Lobstein has found that of the left side tripled in size by a chalky mass in a man who had long been

(1) Bichat, *Anat. descript.* vol. v. p. 462.
(2) *Abhandlungen*, 1806, p. 164.
(3) Fourcroy, *Médecine éclairéa*, vol. i. p. 236.

affected with syphilis.(1) We have found these organs unusually large in two individuals much addicted to venery,(2) and deformed in a female shortly after parturition, in whom the uterus and one of the ovaries also presented a similar formation.(3) Otto has seen them twice the usual size, in one case where the genital organs were very much developed.(4)

The great simultaneous development of these two orders of organs in the fetus, the coincidence of their smallness, and even the simultaneousness of their absence with the development of the encephalon, between which and the genital organs there is so striking a connection in an opposite sense, are circumstances in favor of this hypothesis. Another conjecture very similar to this, is to consider the renal capsules as an imperfect rudiment of the genital organs,(5) although it seems to us too doubtful to think, that if they were connected with the kidneys more intimately, an excess of energy, a momentary excitement alone would be necessary for this connection, acting like a real copulation, should cause the renal capsules to produce a new being.

It seems to us less probable that the renal capsules have a mechanical or dynamical relation with the kidneys, because, that when these latter are displaced, the capsules always preserve their normal situation, so that the two organs are then more or less distant.

Finally, it is still less probable that they contribute to produce the fat.(6)

V. ABNORMAL STATE.

§ 2400. The renal capsules are very rarely abnormal,(7) and inasmuch as their anomalies consist in alterations of texture, we may conjecture with great probability, that they depend on the premature extinction of the great power primitively possessed by the organ.

A very general primitive anomaly, is their extreme smallness, or their entire deficiency, which attends the imperfect development of the encephalon, and the upper half of the body generally. Only two or three cases of this kind are known, where the renal capsules were found of their usual size. Their imperfect development not only attends alterations of the cerebrum, but the suspended development of this viscus generally, particularly congenital hydrocephalus.

(1) *Rapport sur les travaux anatomiques*, Strasburg, 1805.
(2) *Abhandlungen*, p. 185–186.
(3) *Ibid.*, p. 159.
(4) *Pathologisch-anatomische Beobachtungen*, 1816, p. 139.
(5) L. C. Treviranus, *Untersuchungen über wichtige Gegenstande der Naturwissenschaft und Medicin*, Gottingen, 1803, p. 184.
(6) Riegels, *loc. cit.*
(7) Lauth, in Lobstein, *loc. cit.*, p. 36.—Dupuytren, in Meckel, *Abhandlungen*, p. 141. Our observations perfectly agree with his.

The number of the renal capsules sometimes(1) increases, an interesting phenomenon, as it resembles one rather common in an adjacent organ, the spleen.

It is difficult to determine whether this state be only a simple division, or whether we should consider it as a real increase in the substance of the renal capsules. Considered in the last point of view, it would gradually lead to the hypertrophy of these organs, some cases of which are known.(2)

This hypertrophy is rare: we may presume that it generally depends on an alteration of texture, and it seems particularly coincident with anomalies in the genital organs.

CHAPTER IV.

OF THE GENITAL SYSTEM.

§ 2401. The *organs* of *generation*, the *genital parts* (*partes*, s. *organa sexualia*, *genitalia*, s. *generationi inserventia*),(3) principally serve to perpetuate the species, while the existence of the other systems is directly connected only with that of the individual. They however are directly connected with the organism of the individual, as is demonstrated by the consequences of their absence, whether primitive or congenital, or consecutive and accidental, or produced by a determination of the will. The sexual character which is imprinted on the whole organism, is most evident in them. Of all the organs then, these differ the most in the two sexes. A superficial examination would lead to the conclusion, that the genital organs in the male are entirely different from those of the female, and that they cannot be compared. But if we compare them in any animal, or even in man, we shall be satisfied that they have originally the same form, that they correspond perfectly in respect to number, their essential peculiarities in structure and function, that they differ only in size and situation, and that consequently, the analogies between them are much greater than the differences, and that they should be regarded as modifications of one and the same primitive type.

It is convenient to add the history of the mammæ to that of the genital system, since they contribute but slightly, or not at all, to the organism of the individual, while in their quality of nutritious organs of the infant, they exert a great influence on the preservation of the species. Besides, they do not differ less in the two sexes than the

(1) Duvernoy, *loc. cit.*—Morgagni, *Ep. XX. a.* 43.—Otto, *Seltne Beobachtungen*, vol. lxxxiv.

(2) Harder *Apiar.*, obs. 61.

(3) F. Plazzoni, *De partibus generationi inservientibus, libri III*, Padoue, 1521.—W. Rolfink, *Ordo et methodus generationi dicatarum partium per anatomen cognoscendi fabricam*, Jena, 1664.—Id., *De sexus utriusque partibus genitalibus specimen*, Leipsic, 1675.—Van Horne, *Prodromus observationum suarum circa partes genitales in utroque sexu*, Leyden, 1668.

other organs of generation. It would be better then, instead of employing the expressions *sexual parts* and *genital parts* indiscriminately, as is generally done, to confine the latter term to the organs which produce the new being, that is, to the proper genital organs.

All these parts differ from most others, as their active state is proportionally very slight, for it generally does not extend much beyond the half of existence, during which it appears only at long intervals, and requires also, in order to be brought into action, very general, and often very great changes, both in the mode of vitality, and in the structure of the organs.

ARTICLE FIRST.

GENITAL ORGANS IN THE NORMAL STATE.

1. PROPER GENITAL ORGANS.

§ 2402. The proper genital organs occupy the lower part of the trunk, and are situated within and on the surface of the pelvis.

Those of the male and female differ principally in this respect, that the first are situated more externally, and are arranged more longitudinally, while the second are placed more internally. Those parts which in the male are situated on the outside of the abdominal cavity, exist in the female within the cavity of the pelvis, and even those which occupy the cavity of the pelvis in the male, are pushed forward so much that they are found directly below the common integuments. Thus, while the external genital organs in the female, those seen without opening the body, are much fewer and smaller than the internal, the opposite is true of the male; but we shall demonstrate hereafter, that this difference also does not exist during the whole of life.

§ 2403. The best mode is to divide the genital organs, in the two sexes, according to the functions of their different constituent parts; into the *proper genital* or *formative* organs (*organa generationis*, s. *formantia*), and the *organs of copulation* (*organa copulationis*).

The formative organs in the man, are the testicles with their excretory ducts, the prostate gland, and the glands of Cowper: in the female the ovaries with their excretory ducts, the Fallopian tubes, and the uterus.

The organs of copulation are, in the male, the penis; in the female, the vagina and the vulva.

§ 2404. In both sexes the genital organs are situated at the lowest extremity of the trunk, consequently, directly opposite to the encephalon. In both sexes they differ from the other organs in the symmetrical arrangement, their constituent parts existing in pairs, or in the contrary case, being situated on the median line of the body, which divides them into two equal parts.

A. GENITAL ORGANS OF THE FEMALE.

§ 2405. It is convenient to commence with the genital organs of the female,(1) since the genital organs of the two sexes primarily assume their form.

I. FORMATIVE ORGANS.

§ 2406. The *ovaries* and the *Fallopian tubes* deserve to be examined first, on account of the period at which they appear, and their importance.

A. OVARIES.

a. Form, situation, volume, and weight.

§ 2407. The *ovaries* (*ovaria*, s. *testes muliebres*)(2) are situated at the upper part of the cavity of the pelvis, on the sides of the uterus, to which they are attached only by the *ligament of the ovary* (*l. ovarii*), a portion of the fold of the peritoneum, which attaches the uterus to the pelvis, and is termed the *round* ligament. They are rounded and oblong. Their anterior and posterior faces are convex. Their upper edge is also convex and loose. The lower is straight or a little concave, presenting a real *vascular fissure* (*hylus*). They rest by this latter edge on the upper part of the broad ligament. They become thinner towards their internal and external extremities, but particularly toward the former.

Their surface is usually smooth in virgins, and generally uneven and lacerated in aged females. When perfectly developed, they are about an inch and a half long, about four or five lines high, and a little less in thickness. They weigh about a drachm and a half.

b. Structure.

§ 2408. The ovaries are covered externally by the peritoneum, below which is a very solid and very resisting white fibrous membrane (*tunica albuginea*). These two layers are inseparably united. The internal is perforated at the lower edge of the gland by vessels which pass through it, and are distributed in its tissue.

(1) R. de Graaf, *De mulierum organis generationi inservientibus*, Leyden, 1672.—J. Palfyn, *Description anatomique des parties de la femme qui servent à la génération*, Leyden, 1708.—D. Santorini, *Obs. anat. cap.* XI. *De mulierum partibus procreationi datis.*—J. G. Gunz, *Observationes de utero et naturalibus fœminarum*, Leipsic, 1753.

(2) C. Bartholin, *De ovariis mulierum et generationis historia*, Rome, 1677.—Fasch, *De ovario malierum*, Jena, 1681.—Motz, *De structura, usu, et morbis ovariorum*, Jena, 1789.

When we cut the ovaries, their tissue appears brownish red, they are very vascular, firm, and solid, and vesicles are situated within them.

§ 2409. These *vesicles*(1) are termed the *ovula of Graaf* (*vesiculæ*, s. *ovula Graafiana*), although they were known previously by Vesalius(2) and Fallopius.(3)

In the normal state they are composed of a thin, smooth, and serous membrane, which adheres intimately to the substance of the gland; they are entirely closed and filled with a clear and limpid fluid. They vary in size, and they seem to be developed successively. The largest are about three lines in diameter, they are more numerous on the edge of the ovary than in the centre. In virgins their number varies from eight to twenty.

B. FALLOPIAN TUBES.

§ 2410. The *Fallopian tubes* (*tubæ Fallopianæ*, s. *meatus seminarii*)(4) are the excretory ducts of the ovaries. They are situated before and below these organs, then go from without inward toward the upper edge of the uterus, passing through the upper end of the broad ligament (*ala vespertilionum*), to which they are attached.

They are very tortuous, especially in their external portion, and gradually enlarge, so that their diameter, which is only half a line on the inside, becomes by degrees three and four lines. They open into the abdomen (*ostium abdominale*) by a mouth surrounded with a fimbriated edge, called the *morsus diaboli*. This opening projects much on the outside of the outer extremity of the ovary. The internal orifice (*ostium uterinum*) opens in the angle formed by the union of the upper edge of the uterus with its sides. There is no mark of valve or prominence here. Each tube is about five inches long.

§ 2411. The tubes are covered by the peritoneum, which forms their external tunic, and which is continuous with the inner membrane on the edges of the abdominal orifice.

Below the peritoneal tunic is the middle membrane, in which we cannot usually observe any fibres, but it is sometimes composed in vigorous females of two muscular layers, which are formed, the external by longitudinal fibres, and the internal by circular fibres.(5)

The internal mucous membrane is smooth, and presents numerous longitudinal folds.

(1) Bartholin, *De fœminarum ovis*, Leyden, 1684.
(2) *De corporis humani fabricâ*, lib. v. cap. xv. p. 459.
(3) *Obs. anat.*; in the *Opp. omn.* Venice, 1606, vol. i. p. 106.
(4) Bartholin, *De tubis uteri*, Leyden, 1684.
(5) Santorini, *loc. cit.*

c. UTERUS.

§ 2412. The *uterus* or *matrix*(1) is the largest of those parts which unite to form the genital system in the female.

a. Form.

§ 2413. It is pyriform, and much more extensive from above downward than from right to left. Its thickness is much less than its breadth. Its upper and largest part, which is termed the *body*, is triangular. It gradually contracts toward the base. The lateral edges are straight, the upper is very convex.

The upper part of the body is called the *base* (*fundus uteri*). The inferior, termed the *neck* (*collum*, s. *cervix uteri*) is nearly cylindrical.

The anterior and posterior faces of the uterus are very convex, the second more so than the first, so that particularly in the early periods of life, we may admit two posterior lateral faces, which unite at an obtuse angle on the median line.

The uterus represents a cavity closed at its upper part, always excepting the narrow orifices of the two Fallopian tubes, but open below and continuous in this direction with the vagina.

§ 2414. The parietes of this organ are very thick, firm and solid, in the perfect state. The middle region of its body, its thickest portion,

(1) J. A. Pratis, *Libri duo de uteris*, Antwerp, 1524.—L. Bonaccioli, *De uteri sectione*, Strasburg, 1529.—M. A. Ulmus, *Uterus muliebris*, Bologna, 1601.—J. Swammerdam, *Miraculum naturæ de uteri muliebris fabricâ*, Leyden, 1672.—C. Drelincourt, *De utero*, Leyden, 1682.—M. B. Valentini, *De novâ matricis analome*, Giessen, 1683.—G. Bartholin, *De utero*, Leyden, 1684.—A. Nuck, *Adenographia curiosa et uteri feminei anatomc nova*, Leyden, 1692.—F. Ruysch, *Tractatus de musculo in fundo uteri observato, antea a nemine detecto*, Amsterdam, 1726.—A. Vater, *De musculo novo uteri*, Amsterdam, 1727.—J. J. Huber, *Uteri muliebris partiumque ad eam facientium præcipuarum ilcrata explicatio; Halleri Icones*, fasc. I. —I. U. Buchwald, *De musculo Ruyschii in fundo uteri*, Copenhagen, 1741.—J. Weitbrecht, *De utero muliebri observationes;* in N. C. Petrop, vol. i. p. 337.—Sue, *Recherches sur la matrice;* in the *Mém. pres.*, vol. v.—J. G. Rœderer, *Icones uteri humani observationibus illustratæ*, Gottingen, 1759.—T. Simson, *Observations concerning the placenta, the two cavities of the uterus, and Ruysch's muscle in fundo uteri;* in the *Edinb. med. essays*, vol. iv. n. 13.—J. G. Walter, *Betrachlungen über die Geburtstheile des weiblichen Geschlechtes*, Berlin, 1776.—J. C. Loder, *De musculosâ uteri structurâ*, Jena, 1782.—J. G. Weisse, *De structura uteri non musculosa sed celluloso-vasculosa*, Wirtemberg, 1784.—G. Azzoguidi, *Observationes ad uteri constructionem pertinentes*, Leyden, 1788.—O. F. Rosenberger, *De viribus partum efficientibus generatim et de utero speciatim, ratione substantiæ musculosæ et vasorum arleriosorum*, Halle, 1791.—C. H. Ribke, *Ueber die Structur der Gebarmutter*, Berlin, 1793.—G. C. Titius, *De uteri structura ex ejusdem functionibus*, Wirtemberg, 1795.—J. F. Lobstein, *Fragment d'anatomie physiologique sur l'organisation de la matrice*, Paris, 1803.—J. C. G. Joerg, *Ueber das Gebarorgan des Menschen und der Säugthiere im schwangern und nicht schwangern Zustande*, Leipsic, 1808.—C. Bell, *On the muscularity of the uterus;* in the *Med. chir. trans.*, vol. iv. 1813, p. 335.—J. B. Belloni, *Memoria sopra la vera struttura dell'utero*, Rovigo, 1821. —Mad. Boivin, *Mémorial de l'art des accouchemens*, Paris, 1824, p. 57.

is half an inch thick. The body is a little thicker, but perhaps a little softer than the neck.

The anterior and posterior parietes gradually grow thin on the outside, and the internal upward, so that their thickness diminishes from four or five lines to one, and thus resembles that of the tubes, which proceed some lines in the substance of the organ, following an oblique direction from above downward, and from without inward.

The form of the cavity of the uterus generally corresponds with its external figure, although it is extremely narrow in regard to the thickness of the parietes, whence it follows, that its anterior and posterior faces almost touch. Its mean breadth does not exceed four lines. The three edges of the body are concave outward and convex inward, while externally, only the upper edge of the uterus is convex outward. The cavity of the neck is circumscribed by faces convex outward, while its outer face is concave, as the organ is contracted a little on its centre. The form of the cavity also differs from that of the outer circumference, in this respect, that it extends above on each side into a long horn, which gradually contracts, and at the summit of which the Fallopian tube opens.

The cavity is narrowest in the neck, particularly on the limit between the neck and the body, where it contracts very much. It is termed in this place the *upper* or *internal orifice of the uterus* (*ostium uteri internum*).

Thence, the neck enlarges to about its centre, and then again contracts. It terminates below in the upper extremity of the vagina, by two sacs, an anterior and a posterior, the latter of which is usually longer, but the anterior descends a little lower, and between which we usually observe a transverse fissure, more rarely a smaller rounded opening, termed the *os tincæ*, the *external* or *vaginal orifice of the uterus* (*orificium uteri externum*, *os uterinum*). The two sacs are termed the *lips* (*labia*) of this orifice.

The inner face of the uterus is smooth in the body, but corrugated in the neck, along the anterior and posterior parietes of which is a longitudinal prominence, which gradually diminishes from above downward, the sides of which present oblique bands, which render it very uneven. On the sides between the two prominences we observe also numerous elevations, which intercross like a net-work. The lips of the os tincæ are smooth, at least if we except lacerations, which are always accidental, and occur rather frequently during parturition.

b. Volume.

§ 2415. In virgins the uterus is about two inches long, nearly half of which is formed by the neck. The greatest breadth of the body is sixteen lines, and that of the neck from nine to ten. The lips of the os tincæ are about ten lines broad, and the breadth of the external orifice of the uterus is about six.

The vaginal portion of the uterus is about six lines thick, and the fissure is very narrow in this direction.

In females who have borne children the uterus commonly never returns to its primitive dimensions, and the orifice of the os tincæ also appears a little broader from before backward.

c. Weight.

§ 2416. The well developed uterus of a virgin weighs between seven and eight drachms; but in a female who has borne children, and in whom the uterus has contracted as much as possible, it often weighs an ounce and a half.

d. Situation.

§ 2417. The uterus is situated between the bladder and rectum. Its upper half is placed in the cavity of the peritoneum, a fold of which is intimately attached to its surface.

In the perfect state it is situated entirely in the small pelvis, and its base rises only to the level of the upper edge of the symphysis pubis. This part is directed forward and upward: the os tincæ, on the contrary, downward and backward, so that the longitudinal diameter of the axis of the organ corresponds nearly to the upper axis of the pelvis, and it cuts the axis of the body backward and downward.

e. Attachments.

§ 2418. The uterus is attached to the adjacent parts by several folds of peritoneum,(1) which are continuous with the serous tunic of its body, from whence they arise inward.

The largest are the *lateral* or *broad* ligaments (*l. uteri lateralia*, s. *lata*). They pass from the lateral edges of the uterus, receive the vessels of this organ between their anterior and posterior layers, go transversely outward toward the circumference of the pelvis, divide this cavity into two halves, an anterior and a posterior, the first of which is smaller than the second, and are continuous with the lateral wall of the peritoneum.

Beside these vessels, this fold of the peritoneum possesses more or less distinct transverse muscular fibres, which leave the lateral edge of the uterus and gradually terminate on the outside.(2)

(1) J. C. Schutzer, *De fabricâ et morbis ligamentum uteri*, Harderwyck, 1729.—A. Petit, *Description anatomique de deux ligamens de la matrice nouvellement observés*; in the *Mém. de Paris*, 1760.—A. Portal, *Observ. sur la structure des parties de la génération de la femme*; in the *Mém. de Paris*, 1770, p. 183.

(3) Sue, *Recherches sur la matrice*; in the *Mém. prés.*, vol. v., p. 248.

Another fold, which is much smaller, elongated, and rounded, forms on each side the *posterior inferior* ligament, or the *semilunar fold of Douglas* (*l. uteri inferius posterius*, s. *plica semilunaris Douglasii*), which extends from before backward from the lower part of the posterior face of the uterus to the rectum.

This ligament also contains longitudinal muscular fibres.(1)

A third, which is still smaller, the *inferior anterior* ligament (*l. uteri inferius anterius*), one of which generally exists on each side, extends from behind forward from the lower part of the anterior face of the uterus to the bladder, embraces this latter, and frequently also possesses muscular fibres.

Finally we find on each side a very long and rounded ligament, which leaves the upper part of the lateral edge of the uterus, directly below and before the inner extremity of the Fallopian tube; it is termed the *round* ligament (*l. uteri rotundum*, s. *teres*). This ligament is first situated between the two layers of the broad ligament, passes behind the umbilical artery and before the hypogastric vessels, is directed from below upward and from within outward directly behind the peritoneum, towards the upper and external orifice of the inguinal canal, is reflected in this place on the epigastric artery, then enters the inguinal canal, proceeds from above downward, from without inward, and from behind forward, emerges from the inguinal canal through the inguinal ring, and terminates by dividing into several fasciculi in the fat of the mons veneris, and in the upper part of the external labia.

It is composed principally of cellular tissue and vessels, but it possesses also some very distinct longitudinal muscular fibres, the upper of which arise from the external layer of the fibres of the uterus, while the lower come from the lower edge of the two internal broad muscles of the abdomen, which are directed from below upward.

These ligaments keep the uterus in place. The muscular fibres of the broad ligament serve also to approximate the Fallopian tubes to the ovaries.

When the fibres of the broad and round ligaments of one side act more forcibly than those of the opposite side, the uterus is carried transiently or permanently into one half of the pelvis, an arrangement which we have often observed, although it depended on no mechanical cause, and although the parts which serve to retain the uterus were unaltered in their texture.

f. Texture.

§ 2419. At first view the tissue of the uterus seems to be homogeneous; we however distinguish in it when unimpregnated, several layers superimposed from behind forward, which have a reddish yellow color, and between which are whitish bands.

(1) Sue, *ibid.*

The vessels of the uterus, which are very tortuous and frequently anastomose together, proceed between these layers both on the anterior and near the posterior face.

a. Fibres.

§ 2420. There is perhaps in anatomy no subject on which opinions are more divided than in respect to the fibres of the uterus, or, to state the question more exactly, in regard to the existence of these fibres generally, their nature, and their arrangement.

1st. Several anatomists, particularly Walter, Bœhmer, Blumenbach, Azzoguidi, and Ribke, formally deny their existence, which is admitted, on the contrary, by Vesalius, Piccolomini, Malpighi, Morgagni, Diemerbroek, Verheyen, Vieussens, Ruysch, Vater, Santorini, Buchwald, Weitbrecht, Monro, Noortwyk, Heister, Haller, Sue, Astruc, Levret, Rœderer, Meckel, Hunter, Wrisberg, Loder, Mayer, Simson, Calza, Lobstein, and Bell.

Thus the second opinion, which we also have adopted, is supported by most authorities.

But the anatomists who admit their existence differ; some consider the fibrous texture of the uterus as constantly existing; while others, who are more numerous, think that these fibres exist only in certain conditions, as in gestation.

It is a fact that these fibres are at least very slightly apparent, except in pregnancy. They however do not form only during this state, but whenever the formative power of the uterus is exalted. Lobstein has found them very apparent in a female where the uterus was much distended by a steatomatous tumor, as it is generally in the seventh month of pregnancy. He attributes this phenomenon to the distension caused by the tumor; but we have observed them more or less evidently in the uterus of females where analogous tumors existed in the uterus and ovaries, so that we think it more correct to admit that they depend on a change of the proper vitality of the uterus.

2d. Most anatomists consider these fibres as muscular. In fact they differ from the red fibres which form the voluntary muscles, as they are less red, flat, and strongly united with each other; but their muscular nature is proved by their powerful contraction, either during parturition to expel the fetus and the secundines, or afterward, to contract the uterus and almost obliterate its cavity very rapidly.

In these two characters they are very analogous to the involuntary muscles.

This in fact is the manner in which the fibres of the uterus act, and their substance presents in the different states of this organ the different modifications observed in the muscular system of organic life, that is, when the uterus is unimpregnated, they resemble the fibres of the arteries, and during gestation, those of the other involuntary muscles, except the heart.

The uterus of the female contains also a great proportion of fibrine.

Finally we may also mention the analogy with the mammalia, where the uterus is evidently muscular at all periods of life, adding however that by a very remarkable arrangement, the fibres in the uterus of the female do not evidently possess this character, except when the formative power of the organ is increased.

3d. The direction of the fibres is not described in the same manner by all anatomists. Most of them, however, agree that they possess at least two directions, a longitudinal and a transverse; so that in this respect also they resemble the muscles of organic life.

They are however more complex, since we find several layers proceeding in different directions, as the layers composed of fibres which have the same direction proceed several times from within outward; and as finally the different layers frequently interlace together.

Some authors, particularly Malpighi and Monro(1) maintain that the fibres are not arranged regularly.

Ruysch admits only a single, unmated, and circular muscle, situated at the base of the uterus. Although several anatomists, as Vater, Monro, and Simson agree with him, it is however certain that the arrangement of the fibres of the uterus is not so simple. Farther the description Ruysch has given of this muscle is not perfectly exact.

The following are the most general characters of the arrangement of the muscular fibres of the uterus:

1st. There are two layers, an external and an internal, which are separated by the vascular substance of the organ.

2d. The different planes and layers are interlaced so intimately that it is difficult to separate them.

3d. The external layer is much thicker than the internal.

4th. The muscular substance is much thicker at the upper part of the uterus, particularly in its base, than in the other regions. It does not exist at all, or at least is very thin, in the neck.(2)

5th. Generally speaking the longitudinal fibres are much more numerous than the others. The circular fibres, however, are more developed at the base of the organ, while the longitudinal fibres are larger near the lower orifice.

6th. The external plane is composed of longitudinal fibres, which depart from the centre of the base, are distributed from above downward on the anterior and posterior faces, follow an oblique and even transverse direction, and disappear toward the neck. Some of these fibres are irregular, others are continuous with the round ligaments.

7th. According to some authors, Rosenberger for instance, the external plane is composed only of longitudinal fibres; there are however below these fibres other transverse fibres which also go to the round ligaments and to the Fallopian tubes.

(1) *Dissection of a woman with child, with remarks on the gravid uterus;* in the *Edinb. phys. and Med. Essays*, vol. i., p. 459 and 470.
(2) Bell, *loc. cit.*, p. 342.

8th. We also remark in this plane, oblique fibres which have very different directions, and are tortuous; these interrupt particularly the longitudinal layers, and occur principally at the lower part of the body.

9th. The oblique fibres do not exist in the neck, which however is composed, at least frequently, of several superimposed layers of transverse and longitudinal fibres.

10th. The inner plane, which is the thinnest, is formed of two layers. The external is composed of two circular muscles, each situated round one of the orifices of the tubes; they blend together on the median line anteriorly and posteriorly, by the inner part of their edge. Very probably one of these circular layers is the muscle of Ruysch, who had considered the lateral wall of the uterus as the upper, and had neglected the opening of the tube.

11th. Below this layer are longitudinal and oblique fibres, which unite on each side anteriorly and posteriorly to form two elongated triangles, the summits of which blend in the orifice of the tube.

12th. Below these fibres, and interlacing with them, are rather transverse and indistinct fibres, seen particularly at the lower part of the uterus.(1)

(1) Mad. Boivin describes the fibres of the uterus differently. She remarks that after macerating the uterus for a few days, we observe on each face six fibrous fasciculi, three on the right and three on the left of each wall, besides one which is vertical, and which forms the median line. This last layer, which extends from the circumference of the base to the base of the body, presents longitudinal fibres. Each of the others seems to arise from the median line: 1st, at the centre of the base are two fasciculi, one on each side, which extend transversely on the edge of the base to the upper angles, where they fold in the form of tubes, which separate and extend to form the tubes; 2d, below this first layer of the anterior face, two other broader layers, which occupy the upper half of the body, proceed horizontally on each side from the median line, and a little before the angle of the tube, to unite to other layers of fibres, and there form the origin of the round ligament; 3d, at the lower third of the median line two other layers of fibres are directed obliquely from below upward, separating on the sides: one portion of this fasciculus unites to the band of fibres of the round ligaments, and the other blends and interlaces with the transverse fibres of the posterior regions of the organ. On the posterior wall of the uterus the arrangement of the fibrous layers is nearly the same as in the anterior wall. The middle layer is more prominent than that of the anterior face, and also presents longitudinal fibres. The fibrous layers of the upper region extend across, leaving the median line, to the origin of the tubes and a little below, where they unite to go to the ovaries, of which they form the ligament. Below is another layer, which reascends obliquely and divides rather distant from their point of departure into two portions: one superior and lateral, turns on the side, and goes to unite forward to the round ligaments; the other terminates in the form of a ring, and goes to the base of the ovary. At the lower extremity of the median line in the external central region of the neck are two other fasciculi, which are composed of a portion of the fibres of the median line of the neck, separate some lines from each other, are insulated, and are attached to the lateral edges of the middle region of the sacrum, and form the posterior ligaments.

These different fibrous layers change their direction during pregnancy. In proportion as the body of the uterus elongates and enlarges, the layers of fibres of the upper regions from transverse become oblique, their median extremities rise towards the middle of the base, and their lateral extremities are depressed, in the same proportion, to the lower third of the lateral edges of the organ, so that at the end of gestation the fibrous layers of the upper and lateral regions have a radiated arrange-

b. Internal surface.

§ 2421. The inner surface of the uterus is covered by a reddish mucous membrane, which is almost smooth, and presents only some very small villosities, which are continuous above and on each side with those of the tubes, and below with that of the vagina.

In the recent state this membrane adheres so intimately to the subjacent fibrous substance that it is inseparable, although its structure intimates distinctly that it belongs to the class of mucous membranes; but after macerating the uterus we can detach some folds of it by care and precaution.

Its intimate union with the rest of the substance of the uterus has caused its existence to be doubted by several anatomists.(1)

We find some muciparous glands only in the neck, particularly at its lower part. Not unfrequently their orifice is obliterated, perhaps from inflammation. They then form more or less numerous large cysts filled with a limpid liquid, produced by the accumulation of their habitual secretion.

These cysts are termed the *ovula of Naboth* (*ovula Nabothiana*, s. *ovarium secundarium*),(2) which have been very badly compared to the ovula of Graaf.

ment, and may be compared to a head with long hair, separated in all the extent of the median line of the skull, smooth on each side of the forehead, and situated very near and before each ear: this union in a single fasciculus of these superior fibrous layers forms forward and on each side the broad ligaments. The layers of fibres of the lower region of the body have lost progressively the oblique direction assumed by them at first, and become semicircular. These fibrous layers, which leave the lower portion of the median line, unite on the sides and before the middle region of the uterus to the broad ligaments, an inch below the union of the superior fasciculi. The direction of the fibrous layers of the posterior wall is changed in nearly the same manner as those of the anterior face. These layers, which are at first transverse, are arranged obliquely from above downward, and turn on each side. One portion is attached to the ovary, and then projects on the lateral face of the uterus, and the other passes below these glands to unite forward to the anterior fasciculi which form the round ligaments, whence it follows that not only the fibrous layers of the anterior region of the uterus, but also a portion of the middle layers of the posterior region, contribute to form these ligaments. The median layers, which are arranged longitudinally, extend from the base to the origin of the internal orifice of the neck, loose their vertical direction by separating progressively on the sides, and appear at the end of gestation a kind of tissue of fibres, which intercross, and from whence proceed the other layers of fibres which have been described (*Mémorial de l'art des accouchemens*, Paris, 1824). F. T.

(1) This is the opinion of Chaussier and Ribes. Mad. Boivin says also she has never seen this mucous membrane, and thinks that the inner face of the uterus is formed only by the extremities of the exhalent vessels which open there. (*Mémorial des accouchemens*, p. 66.) This explanation is very vague, if not unintelligible. Analogy does not admit us to doubt that the inner face of the uterus is covered by a membrane. F. T.

(2) M. Naboth, *De sterilitate mulierum*, Leipsic, 1707.

II. ORGANS OF COPULATION.

§ 2422. The organs of copulation are composed, in the female, of the vagina, the clitoris, the external labia, and the nymphæ; the three latter have been termed the *external genital parts* (*pudendum*, s. *cunnus*), in opposition to the others, termed the *internal.*

A. VAGINA.

a. Form and dimensions.

§ 2423. The *vagina* is a membranous canal, with thin parietes, generally about four inches long and one broad, and larger at its upper than at its lower part; it is directly continuous with the uterus.

Its upper extremity terminates in a cul-de-sac, called the *base* (*fundus vaginæ*), and is continuous with the substance of the uterus, embracing its lower or vaginal portion.

The other extremity is narrower, and is termed the *entrance* of the vagina (*aditus vaginæ*): it opens externally where it is continuous with the external labia.

b. Situation and direction.

§ 2424. This canal is situated between the rectum, the bladder, and the urethra, to which parts it is united by very loose cellular tissue. It has not the same direction as the uterus, for it descends from behind forward, so that its axis corresponds exactly to the lower axis of the pelvis.

Farther, its posterior wall is slightly convex, and the anterior is concave.

c. Texture.

§ 2425. The vagina is formed of two layers, one external, very thin, solid, and reddish white, which corresponds to the muscular and vascular tunics, is continuous with the fibrous tissue of the uterus, and gradually becomes more solid and vascular from without inward; the internal is reddish, and is firmly united to the preceding, from which however it may be separated.

It is very much corrugated in a full grown female, and particularly in virgins.

Among these folds we see, particularly on the anterior and posterior faces, a series which is transverse and oblique, situated one above another (*columna rugarum anterior et posterior*), which are the conti-

nuation of those in the neck of the uterus, where they are termed the *arbor vitæ.*

There are some muciparous glands at the upper part of the vagina.

B. HYMEN.

§ 2426. The *hymen* (*hymen*, s. *valvula vaginæ*)(1) is a semicircular fold of the mucous membrane of the genital parts, formed of two layers united by cellular tissue; it occupies the sides and the posterior part of the entrance of the vagina, and leaves a greater or less space between its anterior concave edge and the anterior part of the vagina.

Not unfrequently this fold arises from all the edge of the canal. Even then however the opening is generally situated forward and rarely in the centre; the hymen is rarely also thick, hard, solid, and muscular.

This membrane separates the internal and the external genital organs, and also the genital and the urinary systems, as we perceive before it the orifice of the urethra, surrounded by small similar folds.

C. CLITORIS.

a. Clitoris in itself.

§ 2427. The *clitoris* (*clitoris*, s. *membrum muliebre*, s. *coles femina-rum*, s. *nympha*)(2) is an oblong, rounded body, situated below the symphysis pubis. It arises from the upper part of the inner face of the ascending ramus of the ischium by two branches about an inch long, which unite at an obtuse angle.

It terminates forward by a small elongated and rounded prominence, called the *glans of the clitoris* (*G. clitoridis*). This enlargement is covered by a thin mucous membrane, and by a thick and soft epidermis, which is easily detached, and it is surrounded by a triangular fold of skin which entirely envelops it.

This fold of skin, termed the *prepuce of the clitoris* (*præputium clitoridis*), which is closed above and open or cleft below, is thin, soft, and moist on its two faces, but particularly on the internal. We remark in it, especially where the prepuce is continuous with the skin which surrounds the glans of the clitoris, a great number of sebaceous glands.

(1) A. Vater, *De hymene*, Wittemberg, 1727.—J. J. Huber, *De hymene et vaginæ rugis*, Leyden, 1742.—B. S. Albinus, *De hymene;* in the *Annot. acad.*, Leyden, 1758, l. iv., x.—Goering, *De hymene*, Altdorf, 1765.—G. Tolberg, *De varietate hymenum*, Halle, 1791.—B. F. Osiander, *Abhandlung über die Scheidenklappe;* in his *Denkwürdigkeiten für die Geburtshülfe*, vol. ii., pt. i., p. 1.

(2) T. Tronchin, *De nymphâ*, Leyden, 1730.

On a more attentive examination we remark that the glans is not a continuation of the substance of the posterior part of the clitoris, but is attached to it only by cellular tissue, vessels, and nerves, and that the posterior part of the clitoris terminates by a concave surface destined only to support it.

§ 2428. The clitoris is composed of an external fibrous sheath, below which is a spungy tissue formed by broad venous trunks, which frequently anastomose. Thus these lateral parts are termed the *cavernous bodies* (*C. cavernosa*, s. *spongiosa clitoridis*).

After the two branches by which it arises unite, we observe between its two lateral halves a perpendicular fibrous septum, which separates them imperfectly, and which is directly continuous with the external envelop.

There is no trace of a septum in the glans, which is formed of a similar but finer tissue.

By reason of this texture the clitoris is capable of enlarging very much.

Its vessels and nerves proceed on its dorsal face, which are very considerable ; they are numerous and enter, particularly the latter, into the glans.

b. Ischio-cavernosus muscle.

§ 2429. The branches of the clitoris are covered at the lower part of their edge and on each side by a muscle, which arises directly below their lower extremity by short tendinous fibres ; these are attached to the inner branch of the ascending ramus of the ischium, and extend almost to their other extremity. This muscle is called the *ischio-cavernosus* muscle (*M. ischio-cavernosus*, s. *director*, s. *depressor clitoridis*).

It depresses the clitoris, and may contribute to expel the blood which collects in it during erection.

D. NYMPHÆ.

§ 2430. The *small* or *internal labia*, or the *nymphæ* (*L. pudendi internæ*, s. *minores*, s. *nymphæ*), are two oblong, reddish, corrugated folds, similar to the crest of a cock, and very much compressed from right to left ; they are connected posteriorly, and their anterior extremities unite in the glans of the clitoris. The skin which covers them is very delicate, soft, moist, destitute of hair, and similar, especially on its inner side, to a mucous membrane.

Their inner face is continuous with the vagina, and the external with the external labia.

They are formed by a spungy tissue, called the *cavernous body of the nymphæ* and *glans* (*corpus cavernosum nymphæarum et glandis*),

which is finer than that of the clitoris, but is similar to that of the glans, of which it is the direct continuation.

The two branches of the prepuce terminate near the anterior and upper extremity of these folds, and are continuous on the outside with them.

Hence it follows that the nymphæ divide at their anterior extremity into two branches; the internal, which is the smaller, enters into the glans, and the external, or the larger, terminates in the prepuce, and their spungy tissue unites with that of the glans.

The space between them is termed the *vestibule* (*vestibulum*).

E. EXTERNAL LABIA.

§ 2431. The *great* or *external labia* (*L. pudendi externa*, s. *magna*) are considerable folds of skin, directed from before backward, which envelop the other external genital parts. Their external fold is formed by the skin: the internal by a very thin mucous membrane, which is continuous with that of the nymphæ.

They unite anteriorly and posteriorly, thus forming the *anterior* and *posterior commissures*. They are imperceptibly continuous forward with the mons veneris. They are united posteriorly, on the inside and above the posterior commissure, by a thin and transverse fold, termed their *frenum* (*frenulum pudendi*).

The space between the frenum and the posterior commissure is termed the *navicular fossa* (*fossa navicularis*).

F. MUCOUS CRYPTS OF THE EXTERNAL GENITAL PARTS.

§ 2432. The external genital parts are provided with numerous large mucous crypts; they abound particularly around the orifice of the urethra and the entrance of the vagina. The first have been termed the *prostate of Bartholini* (*prostata Bartholiniana*).(1)

G. CONSTRICTOR VAGINÆ MUSCLE.

§ 2433. The upper extremity of the external genital organs in the female is surrounded on a level with the nymphæ by a thin, long, round, and muscular layer, which blends posteriorly with the anterior extremity of the sphincter ani externus muscle, and is attached forward to the branches and the body of the clitoris. This is the *constrictor vaginæ* muscle (*M. constrictor cunni*).

This muscle powerfully contributes to contract the entrance of the vagina.

(1) Bartholini, *De ovariis*, p. 21.

III. VESSELS AND NERVES.

§ 2434. The female genital organs receive their vessels from two sources, principally from the spermatic arteries and the branches of the hypogastric arteries; they are termed the uterine and vaginal arteries, and the arteries of the clitoris, and they are distributed in the parts of the same name. Some twigs of the internal pudic artery also go into the external labia.

The synonymous veins carry the blood into the crural, the hypogastric, and the renal veins.

The spermatic vessels form around the ovaries a very complex plexus, called the *pampiniform body* (*plexus pampiniformis*). They anastomose in the substance of the uterus not only those of one side with those of the other, but those of the upper part with those of the lower.

The nerves of the internal genital parts(1) come from the ganglionnary nerve, and those of the external from the iliac plexus.

IV. PROPERTIES AND FUNCTIONS.

§ 2435. As the external genital parts of the female receive a great number of nerves, they possess an extreme sensibility, which does not exist to the same degrec in the internal.

The uterus by its muscular fibres possesses great powers of contractility, which exist to a certain degree in the vagina also.(2)

The formation of the new being commences in the ovary.(3)

The following facts prove this proposition:

1st. When extirpated, sterility ensues, although all the other parts remain perfect.

2d. Of all the parts of the genital system the first changes after a productive copulation are observed in them.

3d. Fetuses have been found within them.

4th. They have also been found in the abdomen, without any trace of injury in the parts, and with or without the closing of the tubes.

The tubes rceeive the product of conception which is developed in the ovary, and carry it into the uterus. This is proved:

(1) F. Tiedemann, *Tabulæ nervorum uteri*, Heidelberg, 1822.

(2) Lobstein, in the *Journ. de médecine*, vol. xxxvi., p. 143.

(3) Prevost and Dumas assert (*Mémoire sur la génération dans les mammifères et les premiers indices du développement de l'embryon;* in the *Annales des sc. nat.*, vol. iii., p. 134) that fecundation does not take place in the ovary, because we never find in the pouch covering this organ the spermatic animalculæ, which are considered the agents of fecundation; so that according to them the moment of fecundation is much later than that of copulation, and the ovum is not impregnated until arriving in the Fallopian tube or the uterus it comes in contact with the seminal fluid. How can this theory be reconciled with ovarian pregnancy? F. T.

1st. By the fetuses found in the cavity of the abdomen.

2d. By those found within the tube, especially in the cases where the external or internal orifice of this passage was obliterated.

3d. The uterus is the organ in which the new organism is developed.

This proposition is supported by the following arguments:

1st. The fetus is developed in the uterus, when no anomaly occurs.

2d. Even when the fetus is developed out of the uterus, the latter undergoes the usual changes in its substance and its cavity. The possibility of extra-uterine fœtation, however, proves that it is not absolutely necessary to form the new organism.

The vagina is only the conducting organ of the penis, the semen, and the fetus.

The external parts are the exciting organs, the organs of pleasure, as is proved by their increase of susceptibility before and during coition.

This increase of susceptibility communicated to the internal genital organs and to the organism is attended with the degree of energy or excitement necessary to produce the new being.

B. GENITAL ORGANS OF THE MALE.

I. FORMATIVE ORGANS.

A. TESTICLES.

§ 2436. The most important genital organs in the male are the *testicles* (*didymi*, s. *testes*, s. *testiculi*),(1) or the glands which secrete the semen.

a. Form and situation.

§ 2437. The *testicles* have an elongated, rounded, and an almost oval form. They are situated at the lower part of the trunk, on the sides and below the penis, in a special fold of the skin which is formed like a sac, and is termed the *scrotum*. They communicate with the parts of the genital apparatus situated within the abdomen, by the *spermatic cord* (*funiculus spermaticus*, s. *testicularis*). This cord is formed by their excretory duct, their vessels and nerves, and the cremaster muscle.

(1) R. de Graaf, *De virorum organis generationi inservientibus*, Leyden, 1668.—Leal Leali, *De partibus conficientibus in viro*, Padua, 1686.—Santorini, *De virorum naturalibus*; in the *Obs. anat.*, cap. x.—J. G. Rœderer, *De genitalibus virorum*, Gottingen, 1758.—J. Wilson, *Lectures on the structure and physiology of the male urinary and genital organs of the human body*, London, 1821.

b. Volume and weight.

§ 2438. The testicle alone, that is its substance, when its envelops, except the most internal, are removed, is generally an inch and a half long, one broad, and about nine lines thick.

It usually weighs about four drachms.

c. Composition.

a. Membranes.

§ 2439. The testicles are surrounded with several superimposed layers, which vary in their nature, and are termed *tunics*.(1)

1. Skin of the scrotum.

§ 2440. The external layer is the skin of the scrotum, a fold of the common integuments, which descends from the inguinal region, and terminates between the roots of the penis and the perineum. This fold, which is broader at its lower than at its upper part, differs from the rest of the skin, as it is generally a little darker colored, since it presents distinct hairs, and because there is no fat.

It presents also exactly on the median line a narrow sac, the direction of which is from before backward; this is slightly prominent, and is formed by numerous transverse folds arranged very compactly, and is termed the *raphe*. Although apparently thicker at this part, the scrotum is in fact thinner than in any other.

The epidermis of the scrotum is very solid and thick.

2. Dartos.

§ 2441. Immediately under the skin we find the *dartos* (*tunica carnea*, s. *dartos*), which is situated, in regard to the skin of the scrotum, in the same manner as the adipose substance is in regard to the common integuments, excepting, however, in men who are very fleshy.

It is very vascular, and hence it is reddish, and more or less evidently fibrous. As it is also very contractile, several anatomists, as

(1) J. E. Neubauer, *De tunicis vaginalibus testis et funiculi spermatici dissertatio*, Giessen, 1767.—A. Monro, *Remarks on the spermatic vessels and the scrotum, with its contents;* in his *Medical essays*, vol. v., pt. i., p. 205–222.—J. Brugnone, *De testium in fœtu positu, eorum in scrotum descensu, tunicarum quibus continentur, numero et origine*, Leyden, 1788.—P. A. Bondioli, *Sul numero delle tonache vaginali del testicolo*, Padua, 1780.—J. Tumiati, *Richerche anatomische intorno alle tonache dei testicoli*, Venice, 1790.

Winslow,(1) have considered it as muscular, and have compared it to the subcutaneous muscles ; but accidental or designed emphysema,(2) and the comparative results obtained by macerating it and the platisma myoides muscle, show nothing but cellular tissue.(3) Probably, however, it makes the transition from the mucous to the muscular tissue, and there is between it and the other muscles, about the same relation as between it and the muscles of the superior and inferior animals, in whom the fibrous structure is not very distinct, and is concealed in some measure by the gelatine, an element of muscous tissue, which envelops and conceals the fibrin instead of leaving it exposed, as in the superior animals, where even it is not changed into this substance.

§ 2442. The dartos forms two distinct sacs, which are adapted to each other on the median line, and give rise to the *septum of the scrotum* (*septum scroti*) which corresponds to the raphe. It consequently separates the two testicles, not only in respect to position, but also, and to a certain extent, in that of vitality, although they are not perfectly distinct. Like the mucous tissue in general, it is more or less infiltrated with serum.

3. Cremaster muscle.

§ 2443. The *cremaster* muscle, the *fleshy or erythroid* tunic (*tunica carnea*, s. *erythroides*), is situated below the dartos ; it arises from the horizontal ramus of the pubis, and forms a third layer. This tunic is formed by an external fasciculus, which descends from the lower edge of the two internal broad abdominal muscles, and by an internal fasciculus, which is generally smaller, but is sometimes as large, and rarely larger; this arises from the horizontal ramus of the pubis. It surrounds the spermatic cord, and the internal tunics of the testicle, and is distributed principally on the anterior face, even when it embraces all the surface of the organ. Its fibres describe arches which are convex downward, and separate more from each other the lower they descend.

When there are muscular fibres on the whole surface of the organ, the spermatic cord emerges through the inferior part of the obliquus internus muscle, and not only below its inner edge. Sometimes the internal fasciculus is really or apparently deficient ; the latter case is most common. Sometimes in muscular persons, but very rarely, fasciculi leave the cremaster muscle, and go with the spermatic cord into the abdominal cavity.(4)

This muscle entirely surrounds the cord only at its upper part ; below, its fibres separate.

(1) *Traite du bas-ventre*, § 499.
(2) Morgagni, *Adv. anat.*, vol. iv. an. 1.
(3) Tumiati, p. 142.
(4) Brugnone, *Observations sur les vésicules séminales ;* in the *Mémoires de Turin*, 1786. p. 610.—Penchienati, *ibid.*

It is itself enveloped by a prolongation of the thick cellular sheath which surrounds the obliquus abdominis externus muscle, and its fibres, although separated are united by cellular tissue. This cellular tissue and the cellular sheath which we have mentioned, blend together below, where they alone envelop the testicle, below which they unite with a common vaginal tunic, to give rise to a short but solid tubercle.

This muscle, which is more developed in animals than in man, raises the testicle.

4. Common vaginal tunic of the testicles and spermatic cord.

§ 2444. Next to the erythroid tunic is a layer of mucous tissue, termed the *common vaginal tunic of the testicle and spermatic cord* (*tunica vaginalis testis, et funiculi spermatici communis*). This tunic arises from the mucous tissue which surrounds the peritoneum, and covers the whole cord and testicles: we may by inflating its lower extremity, pass air through the inguinal ring into the cellular layer which covers the anterior and posterior faces of the peritoneum, and even between the layers of the mesentery.

Prolongations proceed inward from the external edge of this layer, and go toward the interior, where they unite together the vessels of the spermatic cord and the vas deferens, but we do not find below it the pretended *proper vaginal tunic of the spermatic cord* (*tunica vaginalis funiculi spermatici propria*), which Neubeauer admits and which he asserts has a distinct cavity, for if after carefully removing this layer from its external surface, the vessels of the spermatic cord be inflated, this air penetrates into every part; and farther, air injected into it, also enters the vessels of the cord. Farther, the common vaginal tunic cannot be considered at its upper part as a special, independent and close serous cylinder, if we reflect, that on removing the cremaster muscle which covers it, it ceases to be impermeable to the air, and that it presents this character only so long as it is surrounded by the muscle and its tendon.

We can at most admit an external layer, similar to the loose layer of the serous membranes, and a reflected fold which surrounds and unites the vessels of the spermatic cord. The first then will be termed the common, and the second the special tunic of the cord.

But below, as far as it covers the proper vaginal tunic of the testicle, this tunic is very firm, evidently fibrous, and adheres intimately to the proper tunic of the gland, especially near its lower extremity.

It is also continuous on the outside in this part with the two tunics which cover it externally.

5. Proper vaginal tunic of the testicle.

§ 2445. We must distinguish from this layer the fifth envelop of the testicle, the *proper vaginal tunic* (*t. vaginalis testis propria*), from which it is perfectly separated.

This tunic is a compound serous membrane. It usually has an oval form, similar to that of the testicle ; it however is rather more extensive, so that its cavity is a third higher than the gland, being two inches and a half high. Sometimes a narrower prolongation, which varies in length, leaves the anterior part of its surface, and penetrates below into the common vaginal tunic, and the two cavities uninterruptedly communicate.

We conclude from our dissections, that this prolongation is never detached exactly from its summit, but always a little below it.

The special vaginal tunic receives in its cavity not only the testicle, but also the whole epididymis and a portion of the spermatic cord. At the place where it is reflected on itself, it receives directly these last two parts in the commencement of its internal and reflected fold. When it has enveloped them, it passes on the upper and lower extremity of the testicle, but covers the gland in its greatest portion, so that the summit and the base of the epididymis are only covered by it in the point by which they look toward the testicle. Thence it goes on the whole circumference of the gland. It is by this fold that the spermatic vessels pass to go to the testicle, and enter at its upper and posterior edge.

The two layers which form this fold are slightly united by cellular tissue, so that they are easily separated. It is not difficult to detach the vaginal tunic from the epididymis ; but it is less easy to separate it from the testicle, excepting for some lines near the posterior edge.

A portion of this membrane which covers the testicle, has been improperly termed by Tumiati,(1) the *conjunctiva*. It is usually called the external layer of the tunica albuginea, a term still more inconvenient.

6. Fibrous or albugineous tunic.

§ 2446. The *fibrous* or *albugineous* membrane (*T. albuginea, anonyma, fibrosa*) is the last and the most internal tunic of the testicle. It directly envelops the substance of the gland, and determines its form. It is thick, solid, silvery, shining, and fibrous. In fact, it is a fibrous membrane.

It forms a single cavity, and is perforated at its upper extremity for the passage of the seminal ducts, and at the posterior edge for that of the spermatic vessels.

(1) *Loc. cit.*, p. 146.

b. Substance of the testicle.

§ 2447. On the inner side of the albugineous membrane, to which it adheres in great part but slightly, is the substance of the testicle,(1) a soft brownish yellow mass, divided by the blood-vessels of the tunic into several *lobules* (*lobuli*),(2) situated one above another. This substance is composed principally of very many minute canals, which are single, and do not ramify and interlace with each other ; they are termed the *seminal canals* (*canaliculi seminales*, s. *vascula serpentina*, s. *ductus seminiferi*). Each lobule includes one of these canals. Their circumvolutions, and they themselves, are united very loosely by a fine cellular tissue, so that they may be easily detached. But it is much more easy to prove by maceration, their very great number, which is about three hundred. Each of them is about sixteen feet long and $\frac{1}{200}$ broad. If attached to one another, they would consequently extend about five thousand feet.

§ 2448. These canals unite near the upper extremity of the testicle, into several larger canals, which pass through the albugineous tunic, and soon produce about twenty others, which are still larger, called the *vasa efferentia*. These latter are united in a single fasciculus by a mucous tissue, wind around from below upward, and form the rounded and enlarged head of the epididymis.

B. EPIDIDYMIS.

§ 2449. The *epididymis*(3) is the commencement of the excretory duct of the testicle. It begins at the upper extremity of this gland by a thicker, enlarged, and rounded part, called the *head*, and descends along its posterior and upper edge. The fasciculi which form the seminal passages, are still separated in the head of the epididymis, although, according to our observations, this part seems to be perforated, even at its upper extremity, only by a simple and very tortuous canal, into which the seminal passages severally open.

The thinnest and longest part of the epididymis, that termed its *tail* (*cauda*), is a simple, but very tortuous canal; it is at first very narrow, but gradually enlarges very much, and becomes more tortuous. It is but loosely attached to the proper vaginal tunic of the testicle by a fold of this membrane, and is reflected on itself from below upward at its lower extremity, and is then called the *ductus deferens*.

It is about thirty feet long.

(1) A. Haller, *De vasis seminalibus observationes*, Gottingen, 1745.—A. Monro, *Description of the seminal vessels;* in the *Edinb. essays phys. and literary*, vol. i. xvi.—Id., *De testibus et de semine in variis animalibus*, Edinburg, 1755.—Id., *Of the seminal ducts;* in the *Observations anatomic. and physiol. wherein Hunter's claim some discoveries is examined*, Edinburg, 1758.—G. Prochaska, *Beobachtungen über die Samengange;* in the *Abhandl. der Jos. Akad.*, vol. i. p. 198–213.

(2) B. S. Albinus, *De teste humano;* in the *Ann. acad.*, l. ii. c. xii.

(3) B. S. Albinus, *De epididymo*; in the *Ann. acad.*, l. ii. c. vi.

C. DUCTUS DEFERENS.

§ 2450. The *ductus deferens* or *vas deferens*,(1) ascends along the posterior and upper edge of the testicle, first in a straight line, then obliquely from within outward. It is tortuous at its origin, but soon becomes straight, and joins the spermatic vessels, with which it is united by cellular tissue, to give rise to the spermatic cord. It ascends directly to the inguinal ring; but in this place its direction changes, and it goes from below upward, and from within outward in the inguinal canal, within which we observe the relation we have indicated, between the blood-vessels and the lymphatics, and the ductus deferens. On leaving this canal it crosses the epigastric artery, and ascends directly before it, then turns behind it on the inside, and upward, and thus comes into the abdominal cavity. Thence it leaves the spermatic vessels at a more or less acute angle, goes inward and downward always on the outside of the peritoneum, which covers only its posterior part, and descends into the small pelvis, converging very much toward that of the opposite side.

§ 2451. The ductus deferens is situated in the pelvis, on the posterior face of the bladder.

It dilates and gradually thickens in its course. At its lowest part, which suddenly dilates considerably, it becomes at the same time very tortuous, less so, however, than at its origin, and gives rise on the outside upward and backward, to a great enlargement, to a kind of purse or cul-de-sac, termed the *seminal vesicle*.

Two very different substances enter into its composition. The external, which is about half a line thick, is of a brownish yellow color, very hard and solid. Very probably it is irritable, although fibres are distinctly seen in it very rarely. Sometimes, however, we have observed circular fibres which it was impossible to mistake.(2)

The inner substance is whitish, and easily separable from the preceding, with which it is united only by a loose cellular tissue. It is a mucous membrane, a prolongation of that of the urethra. It is smooth in most of its extent, but reticulated below for an inch or two.

D. SEMINAL VESICLES.

§ 2452. The *seminal vesicles* (*vesiculæ seminales*, s. *parastatæ*)(3) are situated one on each side, on the outside of the corresponding ductus deferens. They are also intimately adapted to the posterior face of the bladder, and are covered posteriorly by the perito-

(1) B. S. Albinus, *De vasis deferentibus, vesiculis seminalibus, emissariis quibus ad urethram pertinent, ostiolis in capite gallinaginis;* in the *Ann. acad.*, l. iv. c. iii. p. 16.

(2) Leuwenhock (*ep.* xli) has seen also longitudinal fibres.

(3) Haller, *Observationes de vasis seminalibus*, Gottingen. 1745.

neum which adheres to them but slightly. Their breadth is, however, slight in proportion to their length, for they are about two or three lines broad, and four or five inches long; but they appear much shorter, as they are very tortuous.

They are, however, not always simply tortuous or similar to a long cul-de-sac, as Lealis, and since his time Caldani,(1) have asserted. In fact, they more commonly ramify.

Their inner membrane presents numerous inequalities, which produce a kind of net-work with irregular meshes. There is also between the largest folds, a considerable number of less prominent folds, which also render their inner face still more uneven. This arrangement establishes a striking analogy between the seminal vesicles and the gall-bladder.

§ 2453. The lower extremity of the seminal vesicle and of the ductus deferens, opens into an extremely narrow duct some lines long, termed the *ejaculatory duct* (*ductus ejaculatorius*). This duct approaches from behind forward, and from below upward, that of the other side, enters into the substance of the prostate gland, and opens into the urethra, directly at the side of this latter, in the centre of the *verumontanum*.

E. PROSTATE GLAND.

§ 2454. The *prostate* gland (*prostata*) is a triangular (2) body, usually of the size and form of a chestnut; is about an inch broad, one high, and half an inch thick, and weighs about five drachms.

It is situated below and before the bladder, and surrounds the commencement of the urethra posteriorly and on the sides.

It is whitish, hard, and solid, and it is surrounded by a fibrous and resisting membrane.

It is composed of three tubes, two lateral and a central, which is posterior and smaller.

The middle lobe is situated behind and between the two lateral lobes and the ejaculatory ducts, and likewise between these latter and the bladder; it is rounded and smaller than the lateral; its volume however varies. In the centre of its lower face is an oblong rounded eminence, which terminates anteriorly in a narrow and elongated point. This eminence has been termed from its form, the *verumontanum* (*caput gallinaginis*, s. *verumontanum*, s. *colliculus seminalis*). It presents at its centre one or two orifices of the ejaculatory ducts, and on the sides a considerable number of orifices leading to the excretory canals, which are distributed in the substance of the gland. These orifices give passage to a yellowish fluid, the *fluid of the prostate*, which mingles with the semen at the time of emission.

(1) F. Caldani, *Opusc. anat.*, Padoue, 1803.
(2) Home, *On the prostrate gland.*

The excretory ducts of the middle lobe pass immediately through the membranes of the bladder, behind and on the outside of the verumontanum.

II. ORGANS OF COPULATION OR PENIS.

A. FORM AND SITUATION.

§ 2455. The *penis* (*penis*, s. *coles*, s. *priapus*, s. *membrum virile*) is situated forward, and entirely on the outside of the pelvis, below the symphysis pubis, between the thighs. Its form is nearly cylindrical. The common excretory duct of the urine and semen, the *urethra*, passes through it.

It is entirely surrounded by a prolongation of the skin, which in this place is thin and destitute of hairs, and fat. External examination shows even through the skin, that it suddenly enlarges at its anterior extremity, where it presents a considerable prominence, and that it terminates in a blunt point.(1)

a. Glans.

§ 2456. This enlarged portion is the *glans penis*,(2) a rounded triangular body, terminated posteriorly by a rounded sac, termed the *crown* (*corona glandis*), which entirely surrounds it, and forward by a longitudinal groove, the external orifice of the urethra. The contracted portion, situated behind the glans, is its *neck*.

The glans is not exposed; it is covered by three layers of skin.

b. Prepuce.

§ 2457. The first two layers are united by cellular tissue, so that the external is turned outward, and the internal inward. They form the *prepuce* (*preputium*). This fold is fitted to the glans, but is not attached to it, so that it can be drawn backward and forward; the first motion exposes the glans, the second covers it.

The internal layer of the prepuce is soft, reddish, moist, and similar to a mucous membrane.

In the centre, where the two layers are continuous with each other, the prepuce presents apparently a rounded opening, which corresponds

(1) F. Ruysch, *Responsio*, &c. in the epist. xv. *De vas. sanguineorum extremit., &c. hisce accedunt nonnulla circa penem detecta.*—B. S. Albinus, *De Ruyschiano involucro penis externo, et de tunica cellulosa penis;* in the *Ann. acad.*, l. ii. c. xi.—F. Ruysch, *De involucro penis externo*, ibid. l. ii. c. xiii.—L'Admiral, *Icon penis humani cera præparati*, Amsterdam, 1741.—J. H. Thaut. *Diss. de virgæ virilis statu sano et morboso*, Wurzburg, 1808.

(2) F. Ruysch, *Glandis in pene vera structura noviter detecta;* in the *Obs. med. chir.*, cap. c.—B. S. Albinus, *De integumentis glandis penis;* in the *Annot. acad.*, lib. iii. c. ix.

to the anterior orifice of the glans, and which disappears when the prepuce is drawn entirely backward. The latter is corrugated transversely in the same proportion.

The internal layer of the prepuce is reflected a second time behind the glans, but here from behind forward, and covers this organ, intimately adhering to its tissue. This adhesion is almost gradual on the circumference of the glans. In fact the internal fold of the prepuce is loose at its upper part, where it is attached but feebly to the penis; but near the centre of its lower part, it is tense, short, and intimately united to the corresponding portion of the glans, and forms a short perpendicular fold.

This portion of the prepuce is termed the *frenum of the glans* (*frenulum glandis*):

All around the neck and posterior face of the crown, the most internal cutaneous fold of the glans presents numerous rounded depressions, termed the *glands of Tyson* (*glandulæ Tysonianæ*), which secrete a thick and whitish fluid.

This fluid (*smegma præputii*) has a disagreeable smell, and tends very much to solidify.

B. SIZE OF THE PENIS.

§ 2458. When not erected, the penis is about three or four inches long and one inch thick.

C. COMPOSITION.

§ 2459. The penis is attached to the skin, which covers it only very loosely.

It is composed of a thick and fibrous membrane, which determines its form, and of a spongy tissue, principally formed by dilated veins, which is then divided into three distinct bodies. The two upper and lateral are termed the *cavernous bodies of the penis* (*corpora spongiosa*, s. *cavernosa*, s. *nervosa penis*), the inferior is termed the *spungy body of the urethra* (*corpus spongiosum*, s. *cavernosum urethræ*).

The cavernous bodies of the penis and urethra are generally described as a collection of different cellules of the vessels; but these cellules are in fact only dilated veins, and the spungy bodies are composed of a very complex net-work of arteries and veins, as Vesalius(1) and Malpighi(2) had already stated generally in regard to the penis, and Hunter,(3) of the spungy body of the urethra particularly.

(1) *De corporis humani fabricâ*, lib. v. c. xiv. *Corpora hæc... enata ad eum fere modum, ac si ex innumeris arteriarum venarumque fasculis quam tenuissimis, simulque proximé implicatis, retia quædam efformarentur, orbiculatim a nervea illa membraneaque substantia comprehensa.*

(2) *Diss. epist. varii argumenti;* in the *Opp. omn.*, vol. ii. p. 221. *Sinuum speciem in mammarum tubulis et in pene habemus; in his nonnihil sanguinis reperitur, ita ut videantur venarum diverticula, vel saltem ipsarum appendices.*

(3) Hunter, *Obs. on certain parts of the animal œconomy*, p. 43.

This structure had been perfectly demonstrated in the penis of the large animals, as the elephant and the horse, partly by Duvernoy,(1) but particularly by Cuvier(2) and Tiedemann;(3) in the penis of man by Ribes,(4) Moreschi, and Panizza.

a. Cavernous bodies of the penis.

§ 2460. The *cavernous bodies of the penis* form most of the member, that is, its upper parts and its sides. They are more broad than high.

They alone have evidently a fibrous envelop, the fibres of which interlace with each other, and are longitudinal.

They arise on each side by a branch about half an inch long, which comes from the ascending ramus of the ischium; the two branches ascend to meet each other, and unite before the symphysis pubis, where they are surrounded in their whole circumference by a common envelop.

Although they appear simple externally, these bodies are however imperfectly divided into two halves, a right and a left, by a *perpendicular septum* (*septum corporum cavernosorum*), which extends almost their whole length, and is a prolongation of the external fibrous membrane. This septum is formed of very long fibres, compressed from right to left, which extend the whole heigth of the cavernous bodies, and which, forming posteriorly an almost perfect septum, proceed forward, growing thinner, and diminishing much in number so as to leave between them greater or less spaces. The separation which takes place between the two cavernous bodies at their posterior extremity, then gradually disappears forward entirely. They however separate still more at their anterior extremity, although apparently only on the outside, since the external part of their circumference is much longer than the internal, whence their anterior faces, surrounded by the external tunic, unite from without inward at a re-entering angle.

b. Urethra.

§ 2461. The *urethra*(5) proceeds along the lower face of the penis. It begins in the prostate gland, where it is broad. In front of this point

(1) *Comm. Petrop.* a. ii. p. 400. *Venarum ductus solummodo cribriformes, foraminibus undique pertusi ac reluti erosi, a cellulis ægre discriminandi extra capsulam penis, venarum* (s. *brevium tubulorum verticalium*) *formam induentia, in conspectum veniunt.*

(2) *Anat. comparée*, vol. iv.

(3) F. Tiedemann, *Notice sur less corps caverneux de la verge du cheval, suivie de quelques réflexions sur le phénomène de l'érection;* in the *Journ. compl. des. sc. méd.*, vol. iv. p. 282.

(4) *Exposé sommaire de quelques recherches anatomiques, physiologiques et pathologiques;* in the *Mém. de la soc. méd. d'emul.*, vol. vii. p. 605.

(5) A. Littre, *Description de l'urétre de l'homme;* in the *Mém. de Paris*, 1700.—J. P. Werne, *Structura urethræ*, Leyden, 1752.

it contracts much for about an inch, so as to be only one or two lines in diameter. This contracted portion is called the *isthmus of the urethra* (*isthmus urethræ*). It ascends a little obliquely from below upward, and from behind forward, below the symphysis pubis, from which it is about an inch distant, surrounded by a loose spungy tissue, like the urethra in the female, which corresponds only to this portion of the urethra in the male. The canal afterward enlarges very much, and is then surrounded in the rest of its extent by the cavernous body of the urethra, the size of which is generally in direct ratio to its diameter.

The cavernous body of the urethra is largest at the second prominence, where it forms a considerable enlargement called the *bulb of the urethra* (*bulbus urethræ*).

On leaving this point the urethra contracts very much. Its diameter continues about the same to the anterior extremity of the penis; but directly behind and within the glans it enlarges a third time to form the *navicular fossa* (*fossa navicularis*).

The cavernous body of the urethra is enveloped only by a dense cellular tissue, which is not fibrous. It is finer, and of a more delicate tissue than that of the penis, and has no septum. It alone forms the glans anteriorly.

Below this body is a thin and reddish mucous membrane, which is united intimately with it, and has longitudinal folds.

This membrane presents numerous cavities arranged successively as culs-de-sac in a single series, termed the *glands of Littre*.

These cavities are sometimes three lines deep. They are seen only at the lower part of the circumference of the urethra, and their direction is such that their orifice looks forward and their cul-de-sac backward.(1)

(1) As Ducamp's researches have reduced the treatment of strictures of the urethra almost to mathematical accuracy, it is necessary to have a more extensive knowledge of this canal than has been given by Meckel. This may be found in a memoir of Amussat (*Remarques sur l'urètre de l'homme et de la femme;* in the *Archiv. gên. de mêd.*, vol. iv., p. 31 and 347), who has ascertained a very important practical fact, that even in young subjects the urethra is straight or nearly straight when the rectum is empty, and the penis is directed from before backward. We distinguish in it three portions: the *prostatic* portion, with thin parietes, which is enveloped by the prostate gland; it is about twelve or fifteen lines long; the *membranous* portion, the parietes of which are a little thicker; it is from nine to twelve inches long; and the *spungy* portion, which is from about six to seven inches long. Most authors consider the whole canal as ten or twelve inches long; but it is only nine, and very frequently, at least sometimes, even less than eight, as has been stated by F. Whately (*An improved method of treating strictures in the urethra*, London, 1816, p. 68). We may then estimate its mean length as between eight and nine inches, nine inches and six lines and seven inches and six lines being the two extreme proportions observed by Whately in forty-eight different subjects. It is not equally broad in every part. It follows, from Sir E. Home's researches (*Practical observations on the treatment of strictures in the urethra*, London, 1805, vol. i., p. 24), that its diameter is four lines in most of its extent, and that its external orifice is at least one line narrower, since it is only from two and a half to three lines in diameter. Amussat has since proved that the urethra, when the parts which cover it are removed and it is reduced almost to the mucous membrane, represents a cone, the base of which is turned backward, and which is slightly prominent at its membranous portion, contracts opposite the bulb to enlarge suddenly at the commencement

c. Cowper's glands.

§ 2462. Besides the testicles and the prostate gland, we also frequently, but not always, find two or three other small, yellowish, oblong, rounded, hard glands formed of several lobes enveloped by a very dense aponeurotic sheath. These glands are about the size of a large pea, are situated directly below the upper part and a little before the prostate gland.

Their ducts are about an inch and a half long, go forward in the bulb of the urethra, and open from below upward in the sides of this canal by distinct orifices.

The two posterior lateral are termed the *glands of Cowper*.(1) The anterior, which is unmated, is smaller and much less constant than the other two; it is termed the *anterior prostate* gland (*antiprostata.*)

D. MUSCLES OF THE PERINEUM.

a. Special muscles of the penis.

§ 2463. The penis has three muscles, one of which, the *ischio-cavernosus*, belongs to the cavernous bodies of the penis, the second, the *bulbo-cavernosus*, belongs to the spungy body of the urethra, while the third, the *constrictor urethræ* muscle, moves the membranous portion of this canal. All three are situated at the extremity of the penis.

a. Ischio-cavernosus.

§ 2464. The *ischio-cavernosus* muscle, *ischio-uretral*, Ch. (*M. ischio-cavernosus*, s. *erector penis*), resembles that of the clitoris in its origin, attachments, direction, and mode of action; but it is much larger, and sometimes arises by a second head from the sciatic tuberosity.

of the spungy portion, and diminishes imperceptibly to the meatus, so that there is no enlargement in the place corresponding to the glans, that is, in the navicular fossa. Amussat explains the appearance of an enlargement in this latter point, by saying that the tissue of the glans is less soft and the mucous membrane is attached to it more intimately, so that in dividing the urethra, the two halves of the glans remain firm and distinct, while the proper spungy tissue contracts and collapses, being freed from the blood within it. That the navicular fossa is only apparent is proved by extending transversely the spungy portion behind the glans, when it becomes as broad as that situated in the body. He has also given a very exact plate of the urethra (*loc. cit.*, pl. iii., fig. 1 and 2). F. T.

(1) G. Cowper, *Glandularum quarumdam nuper detectarum descriptio*, London, 1702.—L. Terranus, *De glandulis universim et speciatim ad urethram virilem novis*, Leyden, 1729.—G. A. Haase, *De glandulis Cowperi mucosis*, Leipsic, 1803.

b. Bulbo-cavernosus.

§ 2465. The *bulbo-cavernosus* muscle, *bulbo-uretral*, Ch. (*M. accelerator urinæ*, s. *bulbo-cavernosus*), is thin, flat, and nearly rhomboidal. It surrounds the bulb and the posterior part of the urethra. It arises forward from the posterior part of the cavernous body of the penis, and backward from the upper part of the lateral wall of the bulb of the urethra. It terminates anteriorly by a straight edge, which descends from without inward and from before backward, and posteriorly by a rounded edge. It is formed at its anterior part by very oblique fibres, and at its posterior part by fibres which are nearly transverse. It blends on the median line with that of the opposite side so intimately, that frequently they are not separated by a median tendinous line.

c. Constrictor urethræ.

§ 2466. The *constrictor urethræ* muscle, *pubo-uretral*, Ch. (*M. constrictor urethræ*, s. *pubo-urethralis*),(1) is elongated, quadrilateral, and flattened from without inward. It arises by a short tendon a little above the lower edge of the symphysis pubis, some lines below the tendinous attachment of the bladder, directly at the side of the tendon of that of the synonymous muscle, on the inner face of the symphysis. Thence it descends enlarging, is first next that of the opposite side, but removes from it on arriving at the membranous portion of the urethra, to which it is attached, and below which it is blended with its synonymous muscle, so that generally only a tendinous line, corresponding to the median line, indicates their separation.

It usually blends at its anterior extremity with the posterior extremity of the bulbo-cavernosus muscle.

It is frequently united at its lower part by some fibres to the levator ani muscle; but in the rest of its extent it is separated from it only by veins, which arise from the prostate gland and the bladder, proceed from behind forward, and empty into the great dorsal vein of the penis.

The two muscles form a ring around the membranous portion of the urethra; they compress it, and by their convulsive contractions very much increase the difficulty of passing a sound through this portion of the canal.

(1) Wilson, *Description of two muscles surrounding the membranous part of the urethra;* in the *Med. chir. trans. of London*, vol. i., p. 175.

b. Common muscles of the genital parts, the rectum, and the urinary passages.

a. Transversi perinei.

§ 2467. We usually find two muscles on each side, the *transversi perinei* muscles, *ischio-perineal*, Ch., which go inward from the ischium and the pubis, and which are similar, as they are both long.

§ 2468. The *posterior* and *inferior* arises from the inner face of the sciatic tuberosity, goes from without inward and from behind forward, and blends particularly in the female with that of the opposite side and with the anterior extremity of the sphincter ani externus muscle, and slightly also with the posterior extremity of the bulbo-cavernosus and the constrictor vaginæ muscles.

In acting with its synonymous muscle it draws the anus a little backward and compresses it from before backward, and thus favors the expulsion of the feces.

§ 2469. The *anterior* and *superior* arises from the inner face of the lower part of the descending ramus of the pubis, where it is frequently united intimately to the preceding, goes inward and a little forward, blends again with the preceding, that of the opposite side, and the sphincter ani externus muscle, and likewise with the bulbo-cavernosus and the constrictor vaginæ muscles, farther forward than that we have mentioned.

It acts like the posterior, but it also contributes to open in the male the posterior part of the urethra, and in the female the vagina.

§ 2470. The posterior transversus perinei muscle is frequently deficient. In man the two muscles are much nearer each other and much slighter than in the female. In the latter we sometimes find a third, situated between the other two.

b. Levator ani.

§ 2471. The *levator ani* muscle, *sous-pubio-coccygien*, Ch., is broad, thin, and semicircular. It arises forward and upward from the lower part of the symphysis pubis and the horizontal ramus of the pubis; it also comes from the inner face of the body of the ischium to the sciatic spine, above and on the inside of the upper edge of the obturator internus muscle. Thence it goes inward, downward, and backward, so that its anterior fibres are almost perpendicular and the posterior transverse.

It passes behind the lower part of the rectum, and is attached by short tendinous fibres to the lateral edge of the three lower pieces of the coccyx by the posterior part of its inner edge, while by the anterior it blends with that of the opposite side.

It follows from this arrangement that the two muscles form a large ring, which surrounds the lower extremity of the rectum posteriorly, and which in the female is attached very intimately to the vagina before arriving at the rectum.

In the female the anterior part which arises from the symphysis pubis is often separated from the rest.

This muscle raises the lower part of the rectum, contracts it, and thus prevents the prolapsus of the intestine, also favors the expulsion of the feces, carries forward and upward the coccyx, which has been pushed forward by the feces and excrements, and by the fetus in parturition, favors the expulsion of the urine and semen by compressing the bladder and seminal vesicles, and finally prevents prolapsus of the vagina in females.

III. VITAL PROPERTIES AND FUNCTIONS OF THE GENITAL ORGANS IN THE MALE.

§ 2472. The testicles secrete the semen, and are the most important part of the genital organs, since the action of this fluid on the body of the female can alone cause the formation of a perfect new organism.

This is demonstrated by sterility occurring when these organs are extirpated, are congenitally absent or diseased, although the other genital organs are formed normally.

The semen is a whitish and strong smelling liquid; it is composed in 1000 parts: of water 900, animal mucilage 60, phosphate of lime 30, soda 10.(1)

The testicles also perform an important part in the individual organism; for when they do not exist, or when they have been removed, the body and the mind vary more or less from the normal state, the larynx and the voice are not developed, the beard does not grow, in short the individual does not acquire the distinctive characters of his sex.

The semen is carried from the testicles through the ductus deferens into the seminal vesicles, where, like all the other fluids in their reservoirs, it continues a certain time, becomes perfect, and is concentrated by the absorption of its aqueous portion,(2) and perhaps is somewhat modified by mingling with a fluid secreted in the parietes of the vesicles.

In fact, several distinguished anatomists, as Wharton,(3) Van Horne,(4) Swammerdam,(5) and Hunter,(6) have rejected this gene-

(1) Vauquelin, *Annales de chimie*, vol. ix., p. 64.—Berzelius states (*Annales de chimie*, vol. lxxxviii., p. 115) that the semen is formed of a peculiar animal matter and of all the salts of the blood.

(2) G. Eitner, *Semen non resorbetur*, Berlin, 1820.

(3) *De vesiculis seminalibus;* in his *Adenographia*, cap. xxx., p. 208.

(4) *Prodromus observationum suarum circa partes genitales in utroque sexu*, Leyden, 1668.

(5) *Miraculum naturæ*, s. *uteri muliebris natura*, Leyden, 1672, p. 10.

(6) *Observations on the glands situated between the rectum and bladder, called vesiculæ seminales;* in the *Observations on certain parts of the animal economy*,

rally admitted opinion, and assert that the seminal vesicles do not receive the semen, but they only secrete a peculiar fluid supplied by the testicles, and some of them, as Wharton, have considered it as the proper semen. They adduce the following arguments :

1st. The seminal vesicles and the ejaculatory ducts have no common excretory canal.(1)

2d. Their structure is glandular.(2)

3d. A liquid injected to the base of the seminal vesicle penetrates into the ductus deferens.(3)

4th. Several animals, particularly fishes, have seminal vesicles, but no testicles.(4)

5th. The fluid contained in the seminal vesicles differs from the semen, both in man and animals ; it is much brighter and more liquid, and has not the peculiar odor of semen.(5)

6th. The fluid which sometimes comes from the urethra, when violent efforts are made at stool, is very similar to that found in the vesicles.(6)

7th. In males who have lost one testicle,(7) or in whom one of the testicles does not communicate with its seminal vesicle, this latter and even the lower part of the ductus deferens of the same side have been found not contracted or empty, but, on the contrary, larger and fuller than that of the opposite side.(8)

8th. When coition is interrupted, pain is felt in the testicle, and not in the seminal vesicles.(9)

9th. The seminal vesicles are as full in aged men and those who have long been indisposed, as in those who die suddenly, or as in young men.(10)

10th. In several animals there is no communication between the seminal vesicles and the vasa deferentia.(11)

11th. In many animals, particularly in guinea-pigs, the seminal vesicles are filled with fluid after coition.(12)

12th. We find no traces of them in several animals.(13)

London, 1786, 1792, p. 31.—Chaptal, *Mém. où l'on se propose de faire voir que les vésicules séminales ne servent pas de rèservoir à la semence séparée des testicules ;* in the *Journal de physique;* 1787, p. 101.

(1) Wharton, p. 209.—Van Horne.
(2) Ibid.
(3) Swammerdam, *loc. cit.*, p. 10.
(4) Idem, in Brugnone, *Mém. de Turin*, 1786, p. 619.
(5) Hunter, p. 32, 38, 39.
(6) Id., p. 33.
(7) Id., p. 33–36.
(8) Id., p. 37.
(9) Id., p. 37.
(10) Id., p. 37–38.
(11) Id., p. 38.
(12) Id., p. 39.
(13) Id., p. 40.

§ 2473. Many of these facts, however, are but slightly conclusive, or are even incorrect, so that they may be easily refuted, and the old opinion thus be maintained.(1)

1st. The seminal vesicles and the vasa deferentia communicate in the manner mentioned above.

2d. The glandular structure of the vesicles only proves that they secrete, and not that they receive semen.

3d. The facility with which liquids injected into them penetrate into the ductus deferens proves exactly that with which the semen passes from these latter within them.

4th. The organs of fishes said to be seminal vesicles are in fact testicles.

5th. The difference between the liquid in the vesicles and the semen emitted, may depend on a mixture of their proper secretion with that of the testicles. Farther the semen ejaculated is composed of the fluid of the testicles united with that of the seminal vesicles, the prostate gland, the glands of Cowper, and the mucous membrane of the urethra.

6th. It does not follow from this that the liquid ejaculated has not passed from the testicles into the seminal vesicles. Possibly, the fluid expelled during efforts to go to stool, comes from the prostate gland and even from other parts, as a similar thing occurs in dogs which have no seminal vesicles.(2)

7th. Possibly this effect was accidental, which is more probable, since the gall-bladder, when the bile is prevented by a calculus from entering, is often distended to a great degree by the mucus which it secretes.

8th. This opinion is often opposed, at least by experience. Farther when this is not the case it would only prove that the venereal orgasm increases also the action of the testicles, and that the semen emitted comes not only from the vesicles, but also from the glands themselves.

9th. The assertion is not correct, and proves nothing. Even Hunter admits that the seminal vesicles take part in the genital act, so that their uniform depletion under different circumstances is not more surprising, whether the fluid comes from the testicles, or is secreted by the vesicles.

10th. The absence of the seminal vesicles in several animals, does not prove that the semen is not introduced into the reservoirs when they exist. Farther, a communication between the vesicles and the vasa deferentia, really exists in several animals where it is not admit-

(1) De Graaf, *Partium genitalium defensio*, Leyden, 1673.—Needham, Croone, and King, in Birch, *Hist. of the roy. society*, vol. iii., p. 103.—Brugnone, *Observations anatomiques sur les vésicules séminales tendantes à en confirmer l'usage ;* in the *Mém. de Turin*, 1786-1787.—Sœmmerring, *Anmerkungen über Hunter's Aufsatz ;* in Blumenbach, *Medic. Bibl.*, vol. iii., p. 87.

(2) Brugnone, *loc. cit.*, p. 622.

ted by Hunter, as the guinea-pig and the horse, while the pretended seminal vesicles, which according to others do not communicate with the excretory passages of the vesicles, are protsate glands.

11th. There is no proof that a portion of the contents of the seminal vesicles does not escape during coition.

12th. It does not follow that the semen does not run at all in the seminal vesicles in those animals which are provided with these reservoirs.

13th. In whatever position the body may be, the liquid injected through the ductus deferens, arrives sooner into the vesicle than into the ejaculatory passage.(1)

14th. The substances injected into the vesicle generally emerge through the ejaculatory passage before arriving at the ductus deferens, and frequently do not penetrate at all into the latter.(2)

15th. The air and sounds introduced through the orifice of the ductus deferens, easily penetrate into the vesicle, but with difficulty into the ejaculatory passage. Notwithstanding this refutation of Hunter's opinion, we cannot deny that the proper secretion of the seminal vesicles seems to contribute powerfully to elaborate the semen.

§ 2474. The semen comes into the urethra and directly into the prostate gland, where it mingles with a more serous and yellowish white fluid secreted by this gland, and which also contributes to perfect it.(3)

On leaving this point it is sent into the penis by the action principally of the bulbo-cavernosi muscles.

§ 2475. The penis possesses in a great degree the power of enlarging and lengthening by the excitement of the venereal passion. It also becomes hard and stiff, which depends undoubtedly on the dilatation and tension of its fibrous envelop.

Its power of erection depends on the peculiar arrangement of its vessels; when erected it can enter into the vagina of the female; it fills this canal more or less perfectly, and injects the semen into the internal organs of generation, particularly the uterus. The erection of the penis depends on the great excitement of the nervous action, either in the whole system or in the nerves of the penis, which are proportionally very large; a greater quantity of blood is then carried into it by the arteries, and is not resumed by the large and numerous veins of the organ, as rapidly as it flows into it. It has been asserted that the phenomenon of erection ought not be explained thus by the accumulation of blood,(4) but this opinion is completely refuted by the experiments,(5) in which, on cutting the penis when erected, after tying its base, the venous plexuses are found gorged with blood.

(1) De Graaf, *loc. cit.*—Brugnone, p. 620.
(2) Brugnone, *loc. cit.*
(3) Haller, *El. phys.*, vol. viii. p. 454.—Brugnone, *loc. cit.*
(4) Langguth, in Schumann, *De vi imaginationis in fœtum*, Wittemberg, 1790.
(5) R. de Graaf, *De virorum organis*; in *Opp. omn.*, p. 84.—Swammerdam, *Prodr. obs. de part. genit.*, p. 13.—Th. Roose, *Ueber das Anschwellungsvermogen*

§ 2476. The first changes which cause the emission of semen, undoubtedly take place in the glans, since it possesses the most nerves, and is the most sensible part, not only of the penis, but of the whole genital system. The excitement of the nervous action in this part is extended to the whole nervous system, particularly to the nerves of the genital organs, quickens the secretion of the testicles, the seminal vesicles, and the other glands, and causes convulsive motions in the bulbo-cavernosi muscles, which compress the spermatic fluid when it arrives at the posterior part of the urethra, and throw it by jets into this canal, which is rendered straight by the erection of the penis.

II. MAMMÆ.

§ 2477. The *mammæ*(1) are the accessory parts of the genital system, which in man and in all true mammalia, establish a natural relation between the organism of the mother and that of the child, by means of the milk which they secrete, which continues during the early periods of life. In birds, and perhaps also in some reptiles, there exists a similar connection between the mother and the offspring, which continues a longer or shorter period after the birth of the latter. But in these animals it does not occur by a special organ, having the power of secreting a peculiar nutritious fluid. It is only by a portion of the intestinal canal, the *crop* (*ingluvies*), which undergoes about this period a change analogous to that which occurs in the mammæ, but which, however, serves for the mother and the offspring.

I. NUMBER.

§ 2478. The mammæ are two in number; they are glandular organs, conglomerate glands.

Although regularly, they fulfill their function only in the female, they occur also in the male, where they are much less developed; the mammæ of the male, however, are sometimes as large, and their secretion as abundant as those of the female.

des männlichen Gliedes im gesunden Zustande; in *Physiologische Untersuchungen*, Brunswick, 1796, p. 17.

(1) A. Nuch, *Adenographia curiosa*, Leyden, 1691, c. ii.—Mencelius, *De structura mammarum*, Leyden, 1720.—Guntz, *De mammarum fabrica et lactis secretione*, Leipsic, 1734.—Bœhmer, *De ductibus mammarum lactiferis*, Halle, 1742.—Kœlpin, *De structura mammarum*, Gripswald, 1764.—Crusius, *De mammarum fabrica et lactis secretione*, Leipsic, 1785.—Covolo, *De mammis;* in Santorini, *Tabul. septemd.*, p. 92–110.—Girard, *De mammarum structura;* ibid., p. 110–116.—A. Joannides, *De mammarum physiologia*, Halle, 1801.

II. SITUATION AND FORM.

§ 2479. They are situated opposite to one another, one on each side, on the anterior face of the chest, and the region which they occupy in the female is termed the *mammary* region (*regio mammæ*). The glandular substance which forms their base, is surrounded by a great quantity of fat, which gives them a semicircular form. Their base, however, is not perfectly circular, but rather eliptical.

It extends particularly upward and outward, and often to the region of the axilla; it is more circular below and inward. It extends from the third to the seventh rib, and covers most of the pectoralis major muscle; but not unfrequently the most external portion of its lower edge covers also a portion of the serratus magnus muscle.

The edge of the mammæ is not smooth in every part, nor is its thickness uniform. In those females who have borne several children, it presents inequalities, because the gland enlarges irregularly outward, so that irregular prolongations leave its edge.

Nor is the circumference of the mammæ smooth in every part.

It presents in every part analogous prolongations, differing in form, size, and direction, which render its surface uneven, and leave between them greater or less depressions. The lower and internal part of these glands is much thicker than the upper and external.

A little below the centre of the mammæ, in its thickest portion, we perceive a more or less prominent eminence, termed the *nipple* (*mamilla, papilla mammæ*), which is surrounded by a more colored circle, and the level of which is often below that of the common integuments. This circle, the skin of which is thinner and finer than that of the rest of the nipple, is termed the *areola* (*areola mammæ.*)

III. TEXTURE.

§ 2480. The texture of the mammæ is not the same in every part. Almost all its substance is composed of small reddish white *grains* (*acini*), which are distinguished very easily in females during the period of lactation. These grains are about the size of a millet seed. They are composed in turn of smaller vesicles, not rounded, but oblong, which are grooved and ranged in rays. They are united by cellular tissue and vessels.

These grains do not exist toward the centre, in the areola, where we find only a fibrous and whitish substance, which is decomposed by maceration, into a tissue of canals, which are united by cellular substance.

§ 2481. These canals are the extremities of the *milk-ducts* (*ductus galactophori*, s. *lactiferi*). The latter arise by as many small roots as there are grains, and gradually unite in larger trunks, which finally terminate in the centre of the nipple, behind the areola by conical, dila-

tations or sinuses. The excretory passages of the mammary gland are larger than in any other conglomerate gland. The size of the trunks varies according as they receive a greater or less number of branches. Many are very small. The number of great branches which finally unite to give rise to one trunk, varies from four to twelve. The extent of the central sinus is also in direct ratio with the size of the trunks. Sometimes these dilatations are from two to three lines broad; but they are always short, compactly arranged at their internal extremity, and a little separated at their external. The internal extremity of each suddenly contracts into a very small canal, which passes in a straight line through the centre of the nipple to its summit, contracts a little, rarely enlarges in some part of its extent, and finally opens on the surface of the nipple by a very small orifice. All these small canals, which are about the breadth of a finger long, are united very intimately by mucous tissue. Only one canal comes from each dilatation.

§ 2482. The whole milk-passage, which consequently includes the carrying portion, the dilatation, and the excretory canal, is formed by a soft, thin, and transparent membrane, similar to a mucous membrane.

These passages are not exposed in most of their course. The trunks are often situated very deeply in the substance of the gland, and those even which proceed at first on its surface, especially those which come from the prolongations mentioned above, penetrate deeply.

They are formed by the successive union of branches and twigs, which always diminish in caliber; but they do not communicate by anastomosing branches. Nuck(1) and Verheyen(2) have in fact described and figured very large anastomosing branches, situated in the areola, directly at the base of the nipple, which go from one milk-passage to another, and thus form a ring; but no other person has found them, and we also have been unsuccessful, although we have carefully sought for them several times. This anastomosing circle is not only invisible, but also the injection pushed into one milk-passage never flows into another, which would be the case if the anastomoses really existed. The milk-passages are not provided with valves as several observers have stated. Farther, the existence of these valves is refuted by the facility with which injections enter through the nipple. Sometimes, however, we observe fluids, particularly mercury, injected through an opening in one milk-passage, return by another, but always under circumstances which prove the communication exists between the most minute ramifications of the passages. Probably the anastomoses, like the ducts themselves, do not dilate sufficiently to produce this result until toward the end of pregnancy, and during the period of lactation. But the researches of Meckel(3) on the mammæ of females dying in

(1) *Adenographia curiosa*, Leyden, 1691, p. 16. fig. 2.
(2) *Anat. corp. hum.* vol. i. tab. xviii. fig. 4.
(3) J. F. Meckel, *Nova experimenta et observat. de sinibus venarum*, Berlin, 1772, § 4, 5, 9.

parturition, demonstrate their existence as positively, as it refutes that of the anastomoses admitted by Nuck and Verheyen. We have also obtained the same results under similar circumstances.

§ 2483. Notwithstanding these small anastomoses, the mammæ is composed of as many distinct and separate glands as there are milk passages. This is demonstrated by injecting each canal with differently colored fluids, for the injections blend in no part, and the different glands can be detached and separated.

§ 2484. The number of the milk-passages, consequently also that of the conglomerate glands, varies even in the two mammæ of the same female. The old anatomists have reduced the number too much, as they estimated them only at six or seven; Haller, Walter, Covolo, and ourselves, have never found less than fifteen. Our dissections, however, have convinced us that Walter was mistaken in saying that there are never more than fifteen, sometimes we have found more than twenty, as have also Haller and Covolo. Their greatest number is twenty-four, according to Covolo. These that are situated highest, and most on the outside, are, as Walter justly remarks, very small and very narrow, which agrees with the less degree of thickness of the mammary gland at its upper part.

§ 2485. Besides the orifices of these milk-passages on the summit of the nipples, we find in the areola also, others which generally occupy the extremities of the tubercles; these are arranged irregularly, and two or three of them sometimes unite in one.

Several anatomists have considered these tubercles as simple sebaceous glands. Bidloo and Morgagni have sometimes seen coming from them a limpid liquid; Morgagni, Winslow, and Covolo have also seen them supply a more or less thick milk in females, during lactation, and the last phenomenon has been observed also in males by Morgagni. The quantity and the nature of the fluid coming from them, depends on the length of time which has elapsed between the repast and the time of nursing, so that several hours after the repast, or when the child has not nursed for a long time, the milk is abundant, while in the opposite case, some drops of a brighter liquid slowly dribble out.

These tubercles are entirely different from sebaceous glands. We find numerous sebaceous glands on the areola and the nipple, and they never rise above the surface like the tubercles, on which we often observe several. An attentive examination shows in several of these tubercles, one, and sometimes even four small excretory ducts, leading to small glands, which are precisely of the same nature as those we have mentioned, but which, however, are smaller; they are situated directly under the skin of the areola, and are united with each other and with the body of the gland, by cellular tissue. Sometimes, in fact, but rarely, these small glands open into the portion of the integuments of the mammæ, which directly covers the circumference of the areola. They vary in number and size. There are generally from five to ten tubercles.

Thus the small glands and the tubercles in which their excretory ducts terminate, are arranged in regard to the mammary gland, precisely in the same manner as the sublingual glands or the buccal and the labial glands, are in regard to the parotid and the submaxillary, and they cannot, at least in our opinion, be regarded as anomalies, as Hildebrandt thinks them.(1)

§ 2486. The mammary gland is situated in a more or less abundant adipose tissue, which does not form a continuous layer as in every other part, for it enters between the depressions which we have mentioned above, and even contrary to what occurs in the other glands, it penetrates deeply into the substance of the organ, while there is none at its base. We find no fat in the nipple nor behind the areola; this fat is more firm and yellowish than in most of the other regions of the body. The mucous tissue which contains it, also penetrates into all the spaces between the different glands. It condenses on the surface of the organ in a special sheath, nearly similar to those which surround the muscles.

Haller asserts(2) that he has frequently seen milk-passages arise from the fat, which afterwards penetrated into it. Covolo and ourselves have seen nothing like this. We have every reason to think that Haller is mistaken, and that his error must be attributed to the existence of the prolongations mentioned above.

§ 2487. The vessels of the mammæ arise from the external thoracic vessels. Their nerves come from the third and fourth cervical, and from the five or six superior dorsal nerves.

IV. FUNCTIONS.

§ 2488. The function of the mammary gland is to secrete the milk. In the normal state this secretion does not begin until toward the end of gestation. Its history will be more in place after that of the phenomena produced by coition.

ARTICLE SECOND.

PERIODICAL DIFFERENCES IN THE ORGANS OF GENERATION.

§ 2489. Until the sixteenth week there is no trace of the genital organs. When they appear they are formed precisely after the same type in all fetuses; their form, volume, and situation are the same, and there is consequently no distinction of sex. The internal genital organs are formed:

(1) *Lehrbuch der Anatomie des Menschen*, vol. iii. p. 339.
(2) *El. phys.*, vol. vii., p. 8.

1st. Of two very elongated and narrow parts, oblique from without inward and from above downward, situated very high out of the pelvis, and which afterward become either the testicles or ovaries.

2d. Of two canals which are not much narrower, but which are longer and thicker, proceed beyond them above, and descend on their outer side. They produce either the tubes, or the epidydimi and the excretory organs of the semen, and unite out of the pelvis in a common median duct, which becomes either the uterus and vagina, or the prostate gland, seminal vesicle, and posterior part of the urethra.

3d. Of a considerable triangular body, a little enlarged at its anterior extremity, situated first at the lower part of the anterior wall of the abdomen, and which afterward hangs loosely forward. This body is formed of two halves, separated by a fissure which proceeds along its lower face ; it afterward forms the penis or clitoris.

4th. There is soon developed on each side of this last body a fold of skin, which is directed from before backward. These two folds are not united posteriorly. They change into the scrotum, or the external labia.

§ 2490. Home,(1) Autenrieth,(2) and Ackermann(3) had already admitted this primitive identity of the genital organs in all individuals, although they indicated perhaps less exactly and precisely the characters of the primitive form, and the manner in which the differences occur.

As all the fetuses at this period, which we have compared and they are at least fifteen, present exactly the formation described, it is more correct to consider, as is generally done, the raphe of the scrotum and penis as a mark of the separation primitively existing, and which gradually disappears by the closing of the fissure from behind forward, than to regard it, with Autenrieth, as proving a tendency to this separation which really occurs only in the female. Thus we have already said for a long time, reasoning from the facts observed by us, that the genital organs are formed after the same type, particularly after that of the female.(4)

We have already established from observation that their character is still more similar to that of the female in all fetuses,(5) and Tiedemann has confirmed this result, describing very exactly several fetuses very near the moment of their formation.(6)

(1) *Phil. trans.*, 1790.
(2) *Infantis androgyni historia*, Jena, 1805, p. 53.
(3) *Ueber die Verschiedenheit beider Geschlechter ;* in Reil, *Archiv. für die Physiologie*, vol. vii., p. 88.
(4) *Abhandlungen aus der menschlichen und vergleichenden Anatomie*, 1806, vol. ii. We have there described six fetuses of this age.—*Beytruge zur vergleichenden Anatomie*, 1808, vol. i., part i., no. 5. We have there described twelve fetuses of this age.
(5) *Beyträge zur vergleichenden Anatomie*, vol. ii., pt. ii., p. 170, Leipsic, 1812.
(6) *Anatomie der kopflosen Missgeburten*, 1813, p. 80.

These phenomena are curious in two respects :

1st. There are generally no genital organs in most of the lower animals, or at least those which exist correspond to the genital organs of the female in those where there are two sexes, so that in this respect also the same law prevails in the development of the fetus and that of the aminal series.

2d. This explains also the greater frequency of female monstrosities.

Farther the great size of the clitoris, the smallness of the uterus, and perhaps also a real connection between the ovaries and the Fallopian tubes : and secondly, the situation of the testicles in the abdomen, establish still longer between the two sexes a similarity which afterward does not exist.

From the third month of pregnancy, however, the ovaries are always smaller than the testicles ; they are situated more horizontally, and the penis differs from the clitoris, as the fissure has disappeared from its surface.

I. GENITAL ORGANS OF THE FEMALE.

§ 2491. The development of the genital organs of the female differs particularly from that of the genital organs of the male, in the less number of successive periods through which it passes.

I. OVARIES.

§ 2492. At first the ovaries,(1) proportionally speaking, and particularly in regard to the other genital organs, are much larger than they are subsequently. They form for a long time most of these organs, although when the difference of sex is more evident, they are proportionally smaller than the testicles, and this difference even is one of their principal distinctive characters.

At about the middle of the third month of fetal existence, and when the embryo is two inches long, they are hardly a line and one quarter in length, less than half a line high, and a little less than one third of a line thick. In the full-grown fetus they weigh between five and ten grains. They are situated almost horizontally far above the small pelvis, but from their horizontal direction their upper or external extremities do not rise as high as the testicles in the male fetuses of the same age, so that they are very far from touching the kidneys.

Their internal extremities, on the contrary, are so near each other that only the rectum exists between them, which is at this time very narrow, so that the intestine does not completely separate them. Their

(1) Roseumuller, *De ovariis embryonen et fœtuum*, Leipsic, 1802.

form is very elongated, narrow, and prismatic; they become rounded only at puberty, and they are then thicker in proportion to their length. Their capsule is very thin, not only in the full-grown fetus, but also during all the early years of life.

Their tissue is more simple until the middle of the first year of existence. In this respect we have as yet been unable to discover any trace of the vesicles of Graaf before the age of six months, when these vesicles form, and they are then proportionally very large.

In the latter half of the existence of the female the ovaries begin to grow harder and to waste. They lose their smoothness, and their surface appears more or less uneven, because the depressions observed in it are changed into considerable cavities.

This effect depends principally on the disappearance of the parenchyma; but the vesicles also change at the same time; they diminish, their membranes become thicker, and finally their cavity disappears, and they are converted into yellowish or blackish, or often into fibro-cartilaginous or osseous bodies.

The ovaries waste so much in females advanced in life that they sometimes disappear entirely, and the place they occupy is indicated only by the vessels. Frequently then they weigh only twenty grains.

§ 2493. According to several writers, as, for instance, Malpighi,(1) Vallisneri,(2) Santorini,(3) Bertrandi,(4) Brugnone,(5) and Buffon,(6) the formation of the *yellow bodies* (*corpora lutea*) belongs also to the history of the development of the ovaries, because they have been found not only in virgins, but in the young females of animals. But it is not well proved that these bodies have the same origin and the same use as the common yellow bodies; and it is extremely probable that their formation has been preceded by an increase in the activity of the genital organs, arising from some cause. We think it more proper to refer the examination of them to the chapter on the changes produced in the genital parts by conception.

II. TUBES, UTERUS, AND VAGINA.

§ 2494. The Fallopian tubes, the uterus, and the vagina, form at first only a single canal, cleft at its upper part, which is uniformly broad, and which extends uninterruptedly from the abdominal extremity of the tubes to the external orifice of the vagina.

(1) *Diss. ep. var, largum;* in the *Opp. omn.*, Leyden, 1687, vol. ii., p. 223.
(2) *Von der Erzeugung des Menschen und der Thiere*, pt. ii. c. iii., p. 262, 319.
(3) *Obs. anat.*, c. xi., p. 223.
(4) *De glandulæ ovarii corporibus;* in the *Misc. Taur.*, vol. i., p. 104.
(5) *De ovarii eorumque corporibus luteis;* in the *Mém. de Turin*, 1790, p. 393.
(6) *Hist. nat.*, vol. ii., p. 203.

A. TUBES.

§ 2495. The tubes are at first proportionally much thicker and longer than they are subsequently.

They descend at first very obliquely from without inward on the outside of the ovaries, to which they are directly united, but extend much beyond their upper extremity. Until the third month they are united at an acute angle at their lower and inner extremities in a small and median perpendicular mass, which is at first very narrow, but which gradually becomes a little wider, and represents the uterus. They are not tortuous until the fourth month.(1) At five months only they begin to exhibit curves, which are at first very indistinct, and gradually enlarge, so that at eight months and at birth they are more tortuous than in the adult: an arrangement which they preserve also during the first years of life. They seem at first to terminate in a cul-de-sac and by an enlargement.

Their abdominal extremity seems to open at the fourth month, but the fimbriated ends are not developed till afterward. Their cavity is always much larger proportionally the younger the fetus is, and it is always found without difficulty whenever it is sought for.(2)

Between the tubes and the ovaries in the fold of the peritoneum extremely curious vessels(3) exist, not only in the embryo and the fetus, but also during the first years of life; these cannot be injected through the tubes nor through the ovary, so that we cannot consider them as establishing a communication between the cavity of the former and the substance of the latter; they are so similar in their number, situation, and form, to the vasa deferentia of man, that we must consider them at least as tending to the formation of these passages and the epidydimis.

The primitive form of the abdominal extremity of the tube, however, allows us to conjecture, and with some probability, that they communicate first with the ovary, but that the communication is probably closed when the abdominal extremity of the tube opens, and consequently when a new passage forms.

B. UTERUS.

§ 2496. The uterus is at first, and usually even until the end of the third month at least, much broader, and has two horns. The horns are as much longer and their angle of union is more acute the younger

(1) The general opinion then that the tubes are always tortuous in the fetus is not exactly correct. Their primitive straightness is very important, on account of the analogy it establishes, first between them and the intestinal canal during the early periods of existence, and also between them and the oviducts of several animals.

(2) Hirschel and Roesslein have asserted the contrary, but they are wrong.

(3) Rosenmuller, *loc. cit.*

the fetus is. But when this angle entirely disappears, the uterus seems to have two horns. At first it is equally broad in every part, and perfectly smooth; there is no prominence either on the outside or on the inside which separates it from the vagina. It begins to enlarge at its upper extremity about the end of the fourth month. This phenomenon depends on the disappearance of the horns which existed at first, and which are replaced by a single cavity. But this upper part is much smaller the younger the fetus is, whence the neck is larger than the body in the same proportion.

The body gradually increases, so that about the period of puberty the uterus loses its almost cylindrical form, and becomes pyriform. The length of the body is only one fourth of that of the whole organ in the full-grown fetus; it is only one third at thirteeen years old, and does not form one half till after puberty.

At the same time transverse and slightly oblique wrinkles are developed on the anterior and the posterior faces; these converge upwards towards the orifices of the tubes, but are very compact at the lower part where they begin to appear, and gradually extend over the whole of the uterus.

There forms also imperceptibly on the two faces of the organ an elongated eminence which passes through its whole length, and toward which the wrinkles on each side converge from above downward. These wrinkles enlarge very much. They render all the inner face of the uterus very uneven, not only in the full-grown fetus, but also during the early period of life. They however gradually disappear in the body, and at the age of five years its inner face is entirely smooth.

The external orifice of the uterus appears at first as a slightly perceptible prominence of the organ in the vagina; but this prominence gradually increases, so that in the latter periods of fetal existence, the vaginal portion of the uterus is proportionally much larger than subsequently. At seven and eight months less than in the full-grown fetus, and during the first months after birth, all this portion of the organ is very uneven, and also on its external face, presents longitudinal wrinkles, terminated by sharp uneven edges, which are deeply fissured, the grooves of which often occupy all the vaginal portion. This prominence afterwards shortens, becomes smooth externally, takes the form of a glove, and the uterine orifice then appears as a simple and smooth transverse fissure.

The parietes of the uterus are as much thinner in proportion to the cavity, the younger the fetus is. At first they are equally thick in every part; but at five months they become much thicker in the neck than at the upper part. Gradually between the age of five and six years, the thickness again becomes uniform in every part, and preserves its character till puberty, at which time the body is much thicker than the neck.

Thus the uterus does not assume till very late, its form and the normal thickness of its parietes; but it acquires its permanent length

much sooner, at least in great part. It is even proportionally longer at first, for instance in the full-grown fetus, than subsequently.

It is the body principally which grows in the adult, and the uterus then assumes a triangular form. In females advanced in age, it becomes irregularly rounded, which does not depend on previous pregnancies, since the same changes are observed in old unmarried females. At the same time it diminishes in those females who have lived in celibacy.

The consistence and the color of the uterus in old age, resemble those of infancy. At these two periods the organ is hard and white, while in the prime of life it is soft and red.

In the fetus of three or four months, the uterus is situated almost entirely out of the small pelvis, and it extends much beyond in the full-grown fetus. After the age of fifteen years, it is entirely situated in the pelvis, at the base of which it is found in old females.

In the fetus it is almost perpendicular, but its direction gradually changes, so that its greatest diameter is directed almost exactly from before backward.

§ 2497. The functions of the uterus as well as its form, present considerable periodical differences.

At the period of puberty, when the female has the power of conception, there is every month a discharge of blood and serum from the genital organs, which continues some days, and is termed *menstruation* (*menstruatio*, s. *menses*), from its occurring periodically. This discharge disappears with the susceptibility for conception, usually between the fortieth and the fiftieth year. It is not a character belonging exclusively to women.(1) This discharge proceeds from the whole inner face of the uterus.

The discharge usually continues some days, at most a week.

The quantity of blood may be estimated between six and eight ounces.

Its color is dark, from which character alone it is very probably venous,(2) which is not the general opinion.

This conjecture is strengthened by chemical analysis. In fact, Lavagna(3) has found in it no fibrin. But Saissy and Mayer(4) have proved that the venous blood contains less fibrin, and consequently less azote than the arterial blood.

The uterus enlarges a little during menstruation; its vessels dilate and project like villosities on its inner surface.(5)

Menstruation essentially consists undoubtedly in an increase of the vitality of the genital organs of the female, resembling inflammation, and of which hemorrhage is the crisis. This is demonstrated by

(1) Cuvier, *Annales du Muséum*, vol. ix. p. 118–130.—Kahleis, *Remarques sur la menstruation;* in the *Journ. compl. des sc. méd.*, vol. xviii. p. 252.
(2) J. F. Osiander, *Diss. de fluxu menstruo atque uteri prolapsu*, Gottingen, 1808, cap. iii.
(3) In Brugnatelli, *Giornale di fisica*, 1817, p. 397–416.
(4) *Deutsches Archiv für die Physiologie*, vol. iii. p. 534.
(5) Osiander, cap. i–ii.

the irritation in these organs before the period of menstruation, the greater propensity of the female at that time for coition, and the greater facility with which she conceives.

We may also consider it as an attempt to form a new organism. In fact, the changes in the uterus at this period, resemble those observed in it after conception. On the other hand, according to the observations of Denman, Brandis, and Joerg, the menstrual blood is not unfrequently attended with membranous productions, similar to the deciduous membrane which is developed when the female has conceived.

Finally, menstruation may carry off from the body generally, and the genital organs particularly, probably not injurious substances, but at least superfluous blood, for while the female is disposed to conceive, the blood always collects in these organs from one menstruating period to another, to form there a new organism, and during pregnancy and lactation it is employed in other formations.

C. VAGINA.

§ 2498. At first the vagina is not broader than the uterus, and is entirely smooth like it. It begins to be uneven at about the same time. First, at about the fifth month a longitudinal elevation appears on each anterior and posterior face. This elevation afterwards presents very many large transverse folds arranged very compactly. These folds are united by others, which are oblique, and are distributed on the whole circumference of the vagina, so as to render its surface much more uneven and reticulated, as they themselves present numerous fissures and folds. This is the appearance of the vagina at seven and eight months. But the folds gradually diminish; they are less evident in the full-grown fetus; they afterwards gradually disappear, become less prominent, more closely united, farther from each other, so that at the period of puberty, even before coition, the vagina is much smoother, and is only corrugated at its lower extremity on its anterior and posterior faces, in the first more than in the second.

At first the vagina is always proportionally narrower than it is subsequently. It is undoubtedly broadest in proportion, about the seventh and eighth month.

It is always proportionally longer in the fetus than subsequently. It is always more than two inches long in the fetus of eight months, and in the child at birth, while in the adult female its length is seldom more than four inches. This arrangement depends at least in part on the higher situation of the uterus, but not entirely on this, as the vagina is not narrower in the same proportion.

D. HYMEN.

§ 2499. The vagina is much narrower at its lower part than in other places. We discover no trace of the hymen before the middle of gestation. At this time it begins to appear on each side in the form

of a thin and narrow prominence, which is directed from behind forward, so that a longitudinal fissure exists in the centre. This prominence is at first directed downward, and is equally broad in every part; but it gradually becomes broader backward, so as to form a semicircular fold, or rather a rounded and oblong septum, which presents an opening at its anterior extremity. The hymen preserves this form until it is destroyed. The inequalities of the vagina are also continuous in the fetus, on it, and on the orifice of the urethra, from whence they descend on the clitoris, and the inner face of the internal labia.

III. CLITORIS.

§ 2500. When the sexual organs are once developed, the clitoris is proportionally very large, and the more so the younger the fetus is.

At the commencement of the third month, when the latter is at most but two inches long, its length is about one line, and it is half a line thick. In fact, it soon loses these large proportions, but it remains considerable during the whole of gestation, so that a slight examination might easily deceive in regard to the sex of the child, which is more probable, because the scrotum is then very small, and the testicles are situated in the abdomen; but the clitoris is always turned forward and downward, and never looks toward the umbilicus.(1)

This organ presents a deep fissure on the whole of its lower face. At three months we distinguish a longitudinal eminence on the centre of this lower face.

The glans is not entirely exposed until the fourth month; it forms a rounded prominence, and is distinctly separated from the rest of the clitoris. When this period has elapsed, the prepuce grows rapidly, and entirely envelops it. The posterior part of the clitoris is composed of the internal labia and the prepuce; the internal labia are then very much developed during the early periods;(2) we cannot distinguish them from the prepuce, with which they are directly continuous. As the prepuce forms and extends on the glans, a line of demarkation gradually forms between it and the internal labia, the edge of which was at first straight, becomes rounded; at the same time they evidently divide at their anterior part, and on each side, into two branches, the one small and internal, which goes to the glans, the other external, going to the prepuce. Previously there was no trace of these two branches.

Thus the clitoris and the labia form originally but one mass.

(1) Walter, *Physiologie*, vol. ii. p. 328.

(2) According to Osiander (*Abhandlungen über die Scheidenklappe;* in the *Denkwürdigheiten für die Heilkunde*, vol. ii. p. 46), the nymphæ are very imperfect, and hardly perceptible at three and four months; observation disproves this assertion. The fact is, that the internal labia are not so large in proportion to the very large clitoris, as they are afterward, but they are very large in respect to the genital organs and the whole body, so that they cannot be mistaken for what they really are not.

IV. EXTERNAL LABIA.

§ 2501. The external labia are at first, at three months, small, rounded, semicircular sacs, convex outward, much thicker anteriorly than posteriorly, and nearer each other at their anterior than at their posterior extremities, and separated forward by the large clitoris, which projects much beyond them. They gradually enlarge, approach each other, as the clitoris does not increase in the same proportion, become more elevated and thinner, and thus their edge becomes sharper. They never, however, cover the clitoris and the nymphæ entirely, during the early periods of existence; first, because these parts are always considerably large; second, because they themselves are but slightly developed.

II. GENITAL ORGANS IN THE MALE.

§ 2502. The genital organs in the male during their development, pass through several periods, which are very important in a physiological, pathological, and surgical point of view. The differences they present, relate to their situation, form, and size.

I. TESTICLES.

§ 2503. The testicles(1) deserve to be first considered, as they are the most important parts, and appear first.

They form not in the scrotum, but in the abdomen, and particularly in the peritoneal cavity, and has the same relation to it as have all the other organs enveloped by this membrane.

About the middle of the third month their upper extremity still touches the lower extremities of the kidneys. At this time they are situated obliquely from above downward, and from without inward,

(1) Haller, *De herniis congenitis, programma ad dissertationem Steding*, Gottingen, 1749.—Pott, *On ruptures*, 1756, p. 13.—Camper, in *Verhandelingen van het Harlemsche genootschap*, 1761, vol. vi. part i.—J. Hunter and G. Hunter, *Medical commentaries*, London, 1762, p. 1. p. 75.—Id., in *Observations on certain parts of the animal economy*, vol. i.—Arnaud, in *Mémoires de chirurgie*, vol. i. no. i. London, 1768.—Lobstein, *De herniâ congenitâ, in qua intestinum in contactu testis est*, Strasburg, 1771.—J. F. Meckel, *De morbo hernioso congenito singulari*, Berlin, 1772.—Girardi, in Santorini, *Septem. tab.*, Parma, 1775, p. 184-202.—J. B. Palletta, *Nova gubernaculi testis Hunteriani et tunicæ vaginalis anatomica descriptio*, Milan, 1777.—H. A. Wrisberg, *Observationes anatomicæ de testiculorum ex abdomine in scrotum descensu*, Gottingen, 1779.—Vicq-d'Azyr, in *Mém. de Paris*, 1780, p. 494-507.—J. Brugnone, *De testium in fœtu positu, de eorum in scrotum descensu, de tunicarum quibus hic continentur, numero et origine*, Turin, 1785.—Tumiati, *loc. cit.*, p. 541.—J. F. Lobstein, *Recherches et observations anatomico-physiologiques sur la position des testicules dans le bas-ventre du fœtus et leur descente dans le scrotum;* in Schweighæuser, *Archives de l'art des accouchemens*, Strasburg, 1801, vol. i. p. 269.—B. G. Seiler, *Observationes nonnullæ de testiculorum ex abdomine in scrotum descensu et partium genitalium anomaliis*, Leipsic, 1817.

fill the space between the kidney and the bladder, and consequently occupy all the inner face of the ossa ilia.

They are very large, since in the fetus of this age, which is scarcely more than two inches long, they are two lines in length and one line thick. They are rounded and oblong, convex anteriorly and concave posteriorly, and rest on a very broad fold of the peritoneum, which first covers the epidydimis, then goes on the posterior and concave face of the testicle, leaving between them a great space, arises from the posterior face of this gland, but is by no means as high as that, and is very similar to the epiploon. They adhere to this fold so slightly, that their situation is easily changed, and particularly carried outward or inward. The epidydimis rises no higher than the testicle, descends at its side from before backward, and a little from within outward, and is continuous at its lower extremity with the vas deferens, which descends into the small pelvis behind the peritoneum. At the place where this continuation occurs, the whole mass, but the epidydimis and vas deferens particularly, rest directly on a short, very fine, rounded cord, which arises from a depression of the lower wall of the peritoneum, at about the centre of the crural arch, which is also covered by the peritoneal membrane, but less loosely than the testicle, because the fold is shorter in the point which corresponds to it. This cord is infinitely thinner than the testicle and the epidydimis.

It is the *sheath* (*vagina*) of Haller, the *gubernaculum* of Hunter, the *cylinder* of Camper, the *basis* of Gerardi.

After this period the proportionally large size of the testicles rapidly diminishes.

At four months, when the fetus is four inches long from the vertex to the coccyx, their length is scarcely two lines and a half, and their thickness at most but one line. The epidydimis is then larger in proportion to the testicle, than before or afterward. The testicles are situated a little lower, but very little however, but are more remote from the kidneys, being at least four lines from them, because the ossa ilia are much larger. The vas deferens is then reflected a little from below upward on leaving the lower extremity of the epidydimis, so that it describes an arch before descending into the pelvis. The gubernaculum is much larger, and it arises from the region of the inguinal ring, although the peritoneum is not perforated in this place; but is only reflected on itself from below upward, and envelops a mucous mass to which we must attribute the thickness and the more round form of the gubernaculum.

At five months, the testicles are not longer than in the preceding month, but they are about half a line thicker, so that they appear a little rounder than they were then. They have not descended lower, or at least but very little, and they are still more than a line distant from the lower wall of the peritoneum. The gubernaculum, which is then evidently triangular and the summit of which is much thinner than the inguinal ring and goes downward, while its base looks upward, ascends obliquely from within outward. It begins a little below

the inguinal ring, at the upper part of the scrotum, by some distinct fibres, passes through the ring, then receives some fibres from the obliquus internus and transversalis abdominis muscles, behind which it passes, then ascends on the iliacus muscle, and rises directly to the lower extremity of the epidydimis. At its lower part, between the inguinal ring and the place where it appears in the abdominal cavity, we discover before it a prolongation of the peritoneum (*processus peritonei*) which terminates in the ring in a cul-de-sac. This prolongation also descends obliquely from without inward. Its upper orifice is much broader than the lower, and than the gubernaculum which passes through it. This last is filled with a soft and gelatinous mass ; it however contains no cavity. The epidydimis is evidently tortuous at its lower part, and the vas deferens is slightly so at its origin.

At six months the testicles are still situated in the same place. At this time they are only four lines long, and one and a half thick, so that they are proportionally oblong, and almost straight. The epidydimis rises a little above the surface of the glans, and like the vas deferens, it is more distinctly curved than in the preceding month. The same is true of the gubernaculum and the prolongation of the peritoneum. Sometimes we may pass air into the lower part of the gubernaculum, and it is sufficient in certain cases to cut it across to perceive that it is hollow.

Thus, there has hitherto existed a canal, terminated in a cul-de-sac, a prolongation of the peritoneum, which descends from about the centre of the lower tendon of the obliquus abdominis externus muscle, between this muscle and the lower edge of the two broad internal abdominal muscles, and behind which proceeds a prolongation of mucous tissue, which is generally solid, and to which are added some fleshy fibres from the two broad internal abdominal muscles. But the testicle is still loose in the cavity of the peritoneum, where it rests on the upper extremity of the gubernaculum.

At seven months we generally find it directly on the upper extremity of the canal, or more or less within it, so that frequently it does not project at all beyond it, or only in a very small part of its upper extremity. It is usually situated behind the lower edge of the obliquus abdominis externus muscle. The prolongation of the peritoneum then extends downward, to just above the inguinal ring. It seems composed of two layers, the internal of which is thinner, and is continuous with the peritoneum, while the external is a mucous tissue, and is continuous with the sheath of the obliquus abdominis externus muscle, in which are distributed the fleshy fibres coming from the obliquus internus abdominis and the transversalis muscles. The lower part of the prolongation of the peritoneum is filled above by the lower extremity of the epidydimis, and by the commencement of the vas deferens; these rest on a small mass of mucous substance, which rises from the lower extremity of the prolongation of the peritoneum, and they are united with it posteriorly by a fold, which is detached from the posterior wall of this prolongation.

At eight months, the testicle itself usually passes through the inguinal ring, and gradually, until the end of the ninth month, arrives at the bottom of the sacrum, so that its situation is normal about the period of birth. The prolongation of the peritoneum is then considerably elongated; it is open its whole extent, excepting only its lower extremity, which terminates in a cul-de-sac, and it communicates freely by its upper with the proper peritoneal cavity.

After the testicle has descended entirely to the bottom of the peritoneal prolongation and of the scrotum, its cavity still continues to communicate with that of the peritoneum for a greater or less length of time, but not more than a few weeks when the development is perfectly normal. But the canal of union gradually contracts at its centre, a little nearer the top than the bottom, so that usually that portion of the prolongation of the peritoneum which surrounds the testicle, begins to be obliterated near the inguinal ring. The upper portion of the canal from the inguinal ring to the centre of the crural arch, or to the place where the vas deferens joins the spermatic vessels, remains open for a considerable time; but when the child is regularly developed, it is also obliterated during the first months after birth, so that it is finally only indicated by a slight depression, which by no means always exists.

The central portion of the canal of communication also is perfectly obliterated as high as the upper extremity of the testicle, and entirely disappears in most cases. At least we have rarely been able to see any traces of it, although we have made the most careful examinations on this subject. We cannot then agree with Brugnone and Scarpa, that we always find in the adult a special cord, composed of cellular tissue, termed by them the *bridle* (*habenula*), which they consider as the remains of a canal of communication, and the cavity of which they assert can always be demonstrated by maceration.

Thus the canal of union is first obliterated, and then disappears. Adhesion in it results from its serous nature, and like its disappearance, it is perhaps favored by the pressure of the testicle upon it.

§ 2504. Farther, these changes in the situation of the testicles do not occur at the same period, and uniformly on the two sides; one of the two organs usually comes into the scrotum long before the other.

The anomalies in the progress of this phenomenon are as follow:

1st. The early descent of the testicles. This case is rare: Wrisberg has found the testicles in the scrotum at four and five months, and has also remarked that the canal of communication was then obliterated.(1)

2d. A suspension of development, from whence several periods are retarded, or even never supervene. This case is much more common than the preceding. The greatest anomaly is where one testicle or

(1) Loder, *Journal*, vol. i., p. 175.

both remain in the abdomen or in the inguinal region, from whence we may think one or both of these organs are deficient.

In this case the testicles are arranged in regard to their envelops precisely in the same manner as in the fetus, as they are entirely exposed, and are provided with a gubernaculum. The least anomaly is where the peritoneal prolongation is imperfectly obliterated. When this last anomaly exists in the greatest degree, the canal remains entirely open, so that the testicle is inclosed in the same cavity as the other abdominal viscera, although its position is otherwise changed. When the anomaly is less, somctimes and most frequently, only the upper part of the peritoneum is open, which extends between the inguinal ring and the obliquus abdominis internus muscle; sometimes and more rarely the lower part of the prolongation does not adhere, so that not only the layer which surrounds the testicle, and which becomes the external layer of its proper vaginal tunic, forms an oblong and rounded cavity, but also we see arise from the upper extremity of this sac a canal varying in length, which marks the old canal of communication; sometimes finally and more unfrequently, the obliteration occurs regularly at the two extremities of the canal of union, but the central part of this latter continues in a greater or less extent.

We shall mention hereafter the diseases produced by these anomalies.

§ 2505. The testicle differs considerably both in respect to situation and its envelops, whether it is found in the abdominal cavity or in that of the scrotum.

While it is situated in the abdomen, it is surrounded only by the albugineous tunic and the portion of the peritoneum which passes on this membrane.

The fold of the peritoneum, which is attached to the latter, is continuous with the posterior wall of the peritoneum, and at this period the testicle, like the other abdominal viscera, is not inclosed in a proper capsule, with which this serous fold is continuous, as are the lungs or the heart.

The other envelops which cover it in the scrotum are developed at the expense of the gubernaculum, and the prolongation of the peritoneum. The peritoneum becomes the external and loose layer of the proper vaginal tunic of the testicle, with which, when the testicle has descended, the internal layer is continuous, precisely in the same manner as it was previously connected with the external wall of the peritoneum.

The common vaginal tunic of the testicle and the spermatic cord is formed from the cellular tissue within the gubernaculum.

At this period also the fibres coming from the two internal muscles of the abdomen, which were at first ascending, go outward, and form the cremaster muscle. The cellular tunic or the dartos already existed in the scrotum, and the testicle entered it on descending.

These changes depend principally on the fact that the gubernaculum gradually turns, so that its internal face becomes external, and its

upper extremity becomes the lower; hence the epidydimis which is attached to it, and with it the testicle, are necessarily drawn from above downward. The prolongation of the peritoneum also emerges in the same manner outward, and independent of this inversion, since it already exists before the testicle descends, and it supervenes also in hernias which are caused simply by the spontaneous prolapsus of the peritoneum, without any other mechanical change.

The descent of the testicle is generally explained entirely in a mechanical manner, and attributed to the compression produced by the motions of respiration upon the abdominal viscera,(1) or to the weight of the testicle,(2) or to the greater flow of blood into its vessels,(3) or finally to the contraction and inversion or to the reversion of the gubernaculum.(4)

The first opinion is not correct, since when the formation is normal the testicles usually descend in the scrotum long before birth, and they are often found in the abdominal cavity long after parturition, when the formation is abnormal. The second is refuted by the habitual situation of the fetus, as the testicle would ascend against its specific gravity. The third is inadmissible, because if true the testicles should be situated as much lower the younger the fetus is, since then they are proportionally the largest.

The contraction of the gubernaculum doubtless does not cause the gliding of the testicle to the inguinal ring; but it does not contribute to its farther progress in the scrotum, for instead of favoring its motion in this direction it would rather contribute to raise it. We cannot, however, deny that it assists very much to the displacement of the organ, and this is proved positively by the great development of the muscular fibres of the gubernaculum in those animals where the testicles possess alternate motions, whence they enter and leave the cavity of the abdomen alternately.

If sometimes the testicles do not descend, although the gubernaculum exists, we must not conclude that this latter takes no part in the phenomenon, since other circumstances may prevent its action, or at least may produce the effects it generally causes. Farther, its contraction is only one mode of causing the displacement of the testicle, and the cause of this displacement is unknown to us.

§ 2506. When man has passed the period of his virility, the testicles diminish a little, at least frequently; but they rarely waste as much as the ovaries, and the power of impregnation continues longer in the male than that of conception in the female.

The scrotum gradually relaxes more or less, so that the testicles descend lower.

(1) Haller.
(2) Haller, Pott.
(3) Haller, Tumiati.
(4) Paletta, Vicq-d'Azyr, Brugnone.

§ 2507. The secretion of semen commences about the same time that menstruation does, but it usually continues a little longer.

II. PENIS.

§ 2508. About the middle of the third month the glans is not yet covered by the prepuce, and a deep groove separates it posteriorly from the proper penis, which is larger than it.

Its anterior extremity is imperforate; we only perceive a whitish spot at the place where the urethra afterwards opens. But we always observe at this period a longitudinal fissure, which sometimes exists posteriorly on the small portion of the lower face of the glans, and which constantly occupies the anterior extremity of the lower face of the penis situated directly next to it.

Thus the urethra does not extend as far forward as when the development is completed, and farther its anterior part presents a fissure below. This fissure, however, by no means extends to the posterior extremity of the penis.

The scrotum is very small, is separated very distinctly from the penis forward, and is entirely closed.

At four months, the appearance of the scrotum is not changed, but the form of the penis is altered. The glans is a little larger proportionally, is covered by the prepuce at its posterior and inferior part, so that only the lower part of its anterior side is exposed, and we remark at the lower part of its anterior surface a longitudinal fissure, which is the opening of the urethra.

Next comes a state directly opposite, which continues during the whole of gestation. The prepuce is very much enlarged, covers the whole glans, and presents only a very narrow opening; it is adapted so intimately to the surface of this part that it cannot be drawn backward.

Thus in the normal state there is paraphymosis during the early periods of fetal existence, and phymosis during those that succeed.

III. MAMMÆ.

§ 2509. The mammæ are already apparent at the third month of pregnancy, at which period the nipple is scarcely perceptible, but presents a very broad opening. It is worthy of remark that they generally contain during the latter period of gestation, and in the fetus at birth, a lactescent liquid, of which there is often a considerable quantity. Until the period of puberty they present no marked differences in the two sexes; but at this time they enlarge more or less in the female.

They are more or less hard and solid. As age advances they diminish, which occurs sooner when their action has been exhausted by frequent lactations. Even where their mass does not seem diminished, and they are even enlarged, the substance of the gland is, however, replaced by fat.

ARTICLE THIRD.

DIFFERENCES IN THE GENITAL ORGANS PRESENTED BY DIFFERENT RACES.

§ 2510. Beside the differencces depending on the sexes and the periods of life, the genital organs present others which relate to the races of the human species.

The most remarkable are those in the external genital organs of the female and the mammæ.

The internal labia are very long in certain Ethiopian races, among others that of the Boschismans, as we have already mentioned. This is the origin of the *apron* of the Hottentots, which the recent observations of Somerville and Cuvier have demonstrated not to be a new organ.

The mammæ are also very much developed and very long in the Hottentots, who can throw them over their shoulders.

We have already mentioncd the great size of the penis in negroes.

ARTICLE FOURTH.

COMPARISON OF THE MALE AND FEMALE GENITAL ORGANS.

§ 2511. We have already mentioned several times that the genital organs of the two sexes are formed primitively in the same model, and that they should be considered only as modifications of the same fundamental type.

In fact it is easy to demonstrate that all the parts which unite to form this system exist equally in both sexes, and differ only in size, situation, and structure. The analogy appears much greater the younger the fetus is, and that it is founded on the nature of things is proved by the fact that they are originally of the same sex.

The testicles correspond perfectly to the ovaries in form and functions, the vessels and nerves they receive, and even, at first, in situation.

The Fallopian tubes are evidently analogous to the vasa deferentia. We however have reason to think they originally communicate with the ovaries by straight canals, and by a kind of epidydimis similar to that which exists in the male between the vas deferens and the testicle.

The seminal vesicles and the prostate gland undoubtedly correspond to the uterus in respect to situation and connection, with the vasa deferentia, and the Fallopian tubes ; the uterus however is larger and more completely developed, and the orifices of the seminal canals are more remote from each other.

The penis and clitoris are similar in essential respects as to situation and structure. They differ only in their respective size, and because the urethra does not extend under the clitoris. This difference however disappears, when we consider the imperfect development of the clitoris is compensated by that of the vagina or nymphæ, which must consequently be regarded as the penis and urethra of the male, the two lateral halves of which are separated, and which are turned inward instead of outward.

In this respect also the analogy is greater in the early periods, since then the urethra does not extend to the anterior extremity of the penis.

We explain in the same manner the difference between the bulbocavernosi and the constrictor vaginæ muscles. These two muscles correspond ; the two halves of the second, however, are united only on the median line.

The external labia represent the two halves of the scrotum, which are separated.

The mammæ differ only in size, and this difference is almost nothing before the period of puberty.

Thus the analogy of the genital organs of the female is found in the other sex. The history of hermaphrodites will demonstrate that the deviations of formation contribute still more to efface the differences between the two series of organs, and these anomalies produce between them so great a resemblance, that it is often very difficult to determine to what sex the individual really belongs.

ARTICLE FIFTH.

GENITAL ORGANS IN THE ABNORMAL STATE.(1)

1. GENERAL ANOMALIES.

§ 2512. The genital organs present some anomalies common to the two sexes, and others peculiar to one only, a remark which applies also to deviations of formation and alterations of texture. In this respect we must remark, that the corresponding sections of the genital organs usually participate in the same anomalies, or at least present those which are very analogous.

We observe in both sexes:

1st. Suspensions of development and developments continuing after the type of the fetus. Such are:

a. The entire or partial absence of the genital organs. The first anomaly causes the total absence of sex, although the rest of the body sometimes indicates clearly to what sex the individual would have belonged if the genital organs had been developed.

b. Abnormal smallness.

c. The abnormal continuance of a primitive formation.

These anomalies are not rare.

2d. Plurality, which is much less common.

3d. The too early development, although more common than the preceding anomaly, is however a rare phenomenon.

(1) Consult, 1st. On the diseases of the genital organs generally: Vercelloni, *De pudendorum morbis*, Leyden, 1725.—2d. On those of the organs of the female in particular: J. G. Walter, *Ueber die Geburtstheile des weiblichen Geschlechts*, Berlin, 1776.—Justi, *Diss. exhibens observationum seriem circa genitalia muliebria*, Marburg, 1798.—Thamm, *Diss. de genitalium sexus sequioris varietatibus*, Halle, 1799. —3d. On those of the external genital organs of the female: Louis, *De partium externarum generationi inservientium in mulieribus naturali, vitiosâ et morbosa dispositione*, Paris, 1764.—4th. On those of the ovaries; Kruger, *Pathologia ovariorum muliebrium*, Gottingen, 1782.—Motz, *De structura, usu et morbis ovariorum*, Giessen, 1789.—5th. On those of the Fallopian tubes: Leonhardi, *Quædam de tubarum uterinarum morbis*, Wittemberg, 1808.—6th. On those of the matrix and of the vagina: A. Vater, *De morbis uteri*, Wittemberg, 1709.—Haller, *De morbis uteri*, Gottingen, 1753.—Schwarz, *De uteri degeneratione*, Jena, 1792.—Clarke, *Diseases of females*, London, 1814.—7th. On the anomalies of the hymen: G. Tolberg, *De varietate hymenum*, Halle, 1791.—Osiander, *loc. cit.*—8th. On the diseases of the genital organs of the male in general: G. Wadd, *Cases of diseased bladder and testicle*, London, 1815.—9th. On those of the testicle: Henrel, *Diss. de morbis scroti*, Strasburg, 1723.—J. Warner, *Account of the testicles and the diseases to which they are liable*, London, 1774.-10. On those of the prostate gland: E. Home, *Observations pratiques et pathologiques sur le traitement des maladies de la glande prostate*, Paris, 1820.—11th. On those of the penis: Broekhausen, *De excretionis urinæ impedimentis a vitiis membri virilis*, Strasburg, 1781.—Thaut, *De virgæ virilis statu sano et morbosa*, Wurzburg, 1808.—C. Bell, *Engravings of specimens of morbid parts*, London, 1813.—J. Howship, *Practical observations on the diseases of the urinary organs*, London, 1816.

4th. It is less rare to find the characters of both sexes blended in the same individual, one or several parts of whom are formed after the type of one sex, and the rest of the body after that of the other sex. This anomaly essentially constitutes hermaphrodism.

5th. Alterations in texture. They are seen most frequently, and are most developed, in the genital organs. Not a single new formation but has been seen in some part of the genital apparatus, which undoubtedly depends on the energy of the formative power being greater in this than in any other of the organic systems

II. SPECIAL ANOMALIES.

A. DEVIATIONS IN FORMATION.

1. HERMAPHRODISM.

§ 2513. *Hermaphrodism*,(1) which constitutes the second class of deviations of formation in regard to quality, is indicated in the formation of the genital organs, of which alone we shall treat here, by the formation of one part of the sexual system, after a type contrary to that of the rest or of the whole body, that is, with or without an increase in the organs of generation.

The second case is infinitely more common than the first.

The genital organs of the male assume the characters of the female:

1st. By the continuance of the testicle in the abdomen, and generally by the imperfect disappearance of the primitive relations of locality.

2d. By the interruption of the vas deferens.

3d. By the higher situation, the increase in volume, and enlargement of the prostate gland.

4th. By the smallness of the penis.

5th. By the different degrees of its imperforation.

6th. By the division of the scrotum, and the existence between the penis and the anus of a canal similar to the vagina, varying in its dimensions, which leads to the prostate gland, and which is often attended by one of the three preceding anomalies.

7th. By the development of one or of the two mammæ resembling those of the female in respect to size and function.

The genital organs of the female assume the characters of the male:

1st. By the hernia of the ovaries through the inguinal ring.

(1) J. F. Meckel, *Ueber die Zwitterbildungen;* in Reil, *Archiv für die Physiologie*, vol. xii.—Burdach, *Die Metamorphose der Geschlechter, oder Entwichlung der Bildungsstufen durch welche beide Geschlechter in eidander ubergehen;* in his *Analomische Untersuchungen*, part i. 1814.—All the works which have appeared before on the samc subject are mentioned thcre.—Seiler, *Observationes nonnullæ de tcsticulorum ex abdomine in scrotum descensu et partium genitalium anomalis*, Leipsic, 1787.—J. Feiler, *Ueber angeborne menschliche Missbildungen, im allgemeinen, und Hermaphroditen insbesondere*, Leipsic, 1820.

2d. Perhaps by the adhesion of the tubes with these glands.

3d. By the smallness and sloping situation of the uterus.

4th. By the narrowness and shortness of the vagina.

5th. By the enlargement of the clitoris and the extension of the urethra to its surface.

6th. By the adhesion of the large and small labia.

7th. By the imperfect development of the mammæ.

All these anomalies do not necessarily coexist in the same organism: but hermaphrodism, and the equivoeal character of the sex which depends on them, are more marked, the greater the number of those existing.

Generally only one or some of the different parts of the genital apparatus are constructed after different types, and the synonymous parts of the two sides correspond. It is much more rare to find an hermaphrodism so perfect that each of the two lateral faces present all the characters of a different sex.

Finally the greatest degree of hermaphrodism consists in the development of some parts constructed after a sexual type contrary to that of all the others.

But few authentic instances of this last and the preceding anomaly are known, and they all differ in respect to quality and quantity.

All these varieties of hermaphrodism present more or less distinct and perfect analogies with animals.

Hitherto, however, not a single instance of human hermaphrodism is known where the two sexes were so completely united that it was possible either alone or with other individuals to procreate both as a male and female.

All imaginary reasonings, however, cannot demonstrate the impossibility of such a formation, as it exists in many animals, as hermaphrodites have been seen which were very nearly in this state, as several phenomena seem even to prove that a perfect male organism sometimes possesses the creative power, independent of the other sex, and we cannot to a certain extent absolutely refuse this power to the female.

II. DEVIATIONS IN FORMATION OF THE SPECIAL GENITAL ORGANS.

A. GENITAL ORGANS.

a. Ovaries and tubes.

§ 2514. Among the primitive deviations of formation in the ovaries and their excretory ducts, the Fallopian tubes, we remark the following, which arise mostly from suspended development:

1st. The absence of an ovary, or more rarely of the two, with or without simultaneous absence of its tubes.

2d. Smallness.

3d. The absence of the vesicles of Graaf in the ovaries of barren women.

4th.. The closing of the abdominal extremity of the tubes.

This last state is frequently developed after inflammation; it then constitutes a consecutive deviation of formation.

Another anomaly, which is generally congenital, but more rare, consists in the hernia of the ovaries and Fallopian tubes through the inguinal ring, in which case they resemble the testicles.

b. Uterus.

§ 2515. The primitive deviations in the formation of the uterus, most of which consist in its suspended development,(1) are:

1st. Its total or partial absence. In the latter case sometimes the upper and sometimes the lower part is deficient.

2d. Its smallness, with thinness of its parietes.

3d. The continuance of its form at a primitive degree of development.

Here exist several degrees which essentially consist most frequently in a division into two halves.(2)

When the anomaly exists in the greatest degree possible, the uterus is divided at its upper part into two horns, and also divided into two halves by a septum at its lower part. Next come two nearly equal degrees: sometimes the body of the organ is extended into two horns, and the neck is single; sometimes the form of the uterus is normal externally, but its cavity is divided into two halves at its lower part by a septum. Next come two other degrees; in one a groove more or less deep at the bottom of the organ makes it appear imperfectly double horned, in the other, it is single externally, while its body is divided into two portions.

Finally, when the anomaly is as slight as possible, the form of the uterus is only more elongated.

These different degrees in the anomaly present very remarkable resemblances with the formations seen in animals, and with animals situated as much lower in the scale as the deviation is greater.

Primitive deviations of formation consisting in an excess of the formative power, are hardly known. The term *double uterus*(3) has been wrongly applied to those which present several of the anomalies mentioned by us.

The deviations in formation in respect to quality which relate to form and situation, are rarely primitive.

(1) See our *Handbuch der pathologischen Anatomie*, vol. i.

(2) Thamm (*loc. cit.*) has given a complete list of works published on this subject. —F. J. Hunkelmœller, *De vaginâ et utero duplici*, Berlin, 1818.

(3) F. Tiedemann, *Observation d'une grossesse chez une femme dont la matrice était double;* in the *Journ. compl. des sc. méd.*, vol. vi. p. 371.—Mad. Boivin, *Mémorial de l'art des accouchemens*, p. 85.

The uterus however is sometimes oblique, which state is generally blended with its obliquity in respect to situation.(1)

The accidental deviations of formation are:

1st. *Abnormal situation.* The principal varieties of this anomaly are the following:

a. The *situation of the uterus out of the median line*, in which case it generally rests against one of the sides of the pelvis.

b. Obliquity, in which its direction is from one side to the other. This state, especially when the uterus is unimpregnated, generally results from adhesions with the adjacent parts.

c. Retroversion,(2) in which the longitudinal diameter of the uterus corresponds to the antero-posterior diameter of the pelvis, so that its base is directed downward and backward, and its vaginal orifice upward and forward. This anomaly occurs particularly during the fourth month of pregnancy.

d. Prolapsus,(3) where the uterus, most frequently from an inversion of the vagina, descends more or less into the pelvis. When the vagina is entirely inverted the uterus is depressed its whole extent, and the lower orifice is situated at the lower extremity of the tumor formed by it between the thighs. Usually also the neck is more or less elongated, and the uterus adheres to the primitively external face of the inverted vagina.

From the elongation of the neck, however, the body of this latter is rarely situated on the outside of the sac of the vagina. In this deviation of formation the orifice of the uterus is rarely completely effaced.(4)

Sometimes the uterus, even when it contains a fetus, forms a hernia.

2d. *Abnormal form.* One accidental anomaly in the formation of the uterus connects it with the proper deviations of formation, as it is attended with displacement of the organ.

This is *inversion*,(5) which consists essentially in the turning outward of the inner face of the uterus. It appears in several degrees, for sometimes only the base of the uterus approaches the orifice, and sometimes it projects through this opening. The tumor it forms in this latter case differs from prolapsus, as its lower part presents no opening. This fact happens only when the cavity of the uterus is considerably distended and its walls are proportionally thin, and the organ is then compressed or drawn down by the base. Thus it is observed in parturition, in uterine polypi, &c.

(1) Boer, *Abhandlungen geburtschülflichen Inhalts*, vol. i. p. 1.

(2) Cuyper, *De retroversione uteri*, Leyden, 1772.—Korscheck, *De retroverso utero*, Halle, 1799.—One is figured in Hunter, *De utero gravido*, tab. xxvi.

(3) Bœhmer, *De prolapsu et inversione uteri*, Halle, 1745.—It is figured in Ruysch, *Obs. med. chir.*, obs. 2 and 8.—Baillie, *Engr. fasc.* ix. fig. i.—Clarke, *Diseases of females*, London, 1814, tab. i–v.

(4) Beclard and Cloquet, in the *Bull. de la fac. de mêd.*, vol. v. 1816, p. 114.

(5) Van Sanden, *De prolapsu uteri*, Leipsic, 1723.—Saxtorph, *Auszüge aus der Abhandlungen der Copenh. Gelleschaft*, Halle, 1785.—It is figured in Ruysch, *Obs. anat. chir. cent.*, obs. x.—Denman, *Introduction to the practice of midwifery*, tab. xii–xiv.—Baillie, *Engravings*, fasc. ix., fig. 2.

Rupture is a deviation of formation of the uterus occurring under similar circumstances, although it is rare, except in a state of pregnancy; it occurs when parturition is opposed by any cause, and is seen, particularly at the lower part of the organ, in a transverse direction.

The *obliteration* of the cavity of the uterus is generally partial, and commonly occupies the lower part of the organ, to a greater or less extent.

It is sometimes congenital, and may then constitute a primitive anomaly; but it frequently supervenes after suppuration and ulceration.

c. Vagina.

§ 2516. Sometimes the vagina is imperforate, or is even deficient, and a loose cellular tissue exists in its place. This anomaly is most generally primitive. Its least degree is the closing of the canal, or the very great thinness and hardness of the hymen.

Sometimes the vagina is divided in a greater or less extent into two halves by a longitudinal septum, directed from before backward, so that when the division extends to its lower extremity even two hymens exist. This anomaly may or may not be attended with an analogous state of the uterus.

The vagina also presents primitive deviations of formation in respect to length and breadth. In fact it is sometimes extremely narrow and very short, which anomalies exist alone or together.

The most common consecutive deviation of formation is the imperfect(1) or perfect retroversion of the vagina, attending the prolapsus of the uterus. The bladder is then generally drawn downward, and very frequently also we find calculi, which may sometimes produce the disease, and sometimes have been produced by it.(2)

The vagina is sometimes ruptured in the same cases as the uterus, but more rarely than it.

d. External labia.

§ 2517. The external labia are sometimes deficient, from a primitive deviation of formation, or adhere to each other on the median line. These two anomalies result from the permanence of a primitive state of formation.

They rarely contain the abdominal viscera which have escaped through the inguinal ring.

(1) Naudin, *Mémoire sur les chutes partielles du vagin;* in the *Journ. gén. de méd.*, vol. lvi. 1816, p. 259.

(2) Ruysch, *Obs. med. chir.*, obs. i.—Paget (*Lond. med. and phys. Journ.*, vol. vi. p. 391) mentions a stone weighing twenty-seven ounces, attended with several smaller ones, found in a case of prolapsus of the bladder.

Sometimes they enlarge very much, either suddenly, from the metastasis of other diseases, particularly blenorrhea, or slowly and gradually.

e. Internal labia.

§ 2518. Sometimes also the nymphæ are deficient, or adhere. These two states may be primitive or accidental, and developed after an inflammation. In some cases they present an opposite anomaly, and are double or even triple.(1) Their unusual enlargement is commonly consecutive or accidental.

f. Clitoris.

2519. The clitoris is sometimes unusually large, and then resembles the penis in the male, particularly when the urethra extends unusually far forward. Sometimes this part is enlarged in consequence of syphilitic affections, and its texture is altered; it then becomes harder, firmer, and irregular.

Its *fissure* is an anomaly interesting as analogous with animals.

B. GENITAL ORGANS IN THE MALE.

a. Testicles.

§ 2520. The deviations in the formation of the testicles are:

1st. The *absence* of one of these two organs, which must be distinguished from its apparent absence, depending on the gland continuing in the abdomen.

2d. *Smallness.*

3d. Permanence in their primitive situations. This anomaly presents a great many degrees, from the case where the testicle remains below the kidney to that where the canal of communication, which continues some time after leaving the abdomen, is imperfectly obliterated. This last deviation of formation becomes the cause of congenital inguinal hernia.

4th. The interruption of the vas deferens, its termination in a cul-de-sac, the absence of the seminal vesicles.(2)

5th. The plurality of the testicles. This anomaly is very doubtful. The seminal vesicles also are rarely more than two in number.(3)

The consecutive deviations of formation are:

1st. Abnormal enlargement.

2d. Atrophy.

(1) Neubauer, *De triplici nympharum ordine*, Jena, 1774.

(2) See our *Handbuch der pathologischen Anatomie*, vol. i., p. 685.—H. Bosch, *Diss. sistens observationem de vesiculæ seminalis sinistræ defectu, integris testibus, vase vero deferente sinistro clauso*, Leyden, 1813.—Seiler has published an excellent account of the post-mortem examination of a person affected with cryptorchis.

(3) Meckel, *De duplicitate monstrosa*, in *Handbuch der pathologischen Anatomie*, vol. ii. p. 32.

These two states are most frequently attended with alterations of texture.

b. Prostate gland.

§ 2521. The prostate gland is particularly subject to enlargement, which is sometimes attended with a change in its tissue. In this case it is usually said to have become schirrous ; this assertion is true sometimes, but not always. Hypertrophy of the prostate gland often depends on the development in its substance of fibrous or fibro-cartilaginous formations, which are also as common in its corresponding organ, the uterus.(1)

The middle lobe of the prostate gland is often swelled abnormally; but this swelling does not always exist, which is contrary to Home's assertion.

c. Penis.

§ 2522. The penis presents a great number of primitive deviations of formation, which depend principally on a suspension of development, or the permanence of a primitive form. They are:

1st. Absence.

2d. Smallness.

3d. Total or partial imperforation, which presents several differences, either in respect to the degree or the quality, from the closing of the prepuce to the opening of the urethra in the perineum, which is or is not attended with the abnormal smallness of the penis; in this case the lower part of the urethra, and consequently of the penis, are in fact cleft on their lower face.(2)

4th. The narrowness of the prepuce, or *phymosis*, which is generally accidental.

5th. The fissure of the penis at its upper face, which is often attended with that of the bladder, and which when existing alone makes the transition from this latter anomaly to the normal formation.

6th. The complete division of the penis into two halves. This deviation of formation is much more rare than the preceding.(3)

On the other hand, sometimes the penis is more or less perfectly double.

Perhaps we ought to consider as the first degree of this anomaly, the entire separation of the urinary and seminal passages, which has sometimes been observed.

(1) Dupuytren, *Sur les calcules de la prostate ;* in the *Bull. de la fac. de méd.*, vol. vii., p. 135.
(2) Sixtus, *De diffisione genitalium*, Wurtzburg, 1813.
(3) Bamberger, *De intussusceptione membranæ urethræ internæ*, Wurtzburg, 1795.

When the organ is perfectly double, the two penises are situated one at the side of or one above the other. This last anomaly presents a remarkable analogy with the doubling of the tongue, the organ which corresponds to the penis. The first might be regarded as a greater development of the fissure of the penis.

The consecutive deviations of formation comprehend the unusual enlargement of the penis, which commonly supervenes after the development of accidental formations.

The internal membrane of the urethra is rarely reversed.(1)

C. MAMMÆ.

§ 2523. The mammæ are sometimes deficient on one side, or on both.

Their unusual smallness in the female and their abnormal size in the male constitute the first degree of hermaphrodism, especially when in the second case they secrete milk.

Sometimes they are multiplied as in the mammalia. In the first degree of this anomaly one mamma has two nipples: next we find several mammæ one above another, two and even three on each side, or on one only.*

B. ALTERATIONS IN TEXTURE.

A. GENITAL ORGANS IN THE FEMALE.

§ 2524. Of all the parts of the genital system, alterations of texture exist most frequently in the ovaries; here too the most different and the most regular new formations appear. The increase in the size of the ovaries must generally be attributed to the formation of these accidental productions, although it is sometimes, especially at first, only simple hypertrophy, either in the whole substance of the gland, or, as is more frequent, of one of its constituent parts, the vesicles. The enlargement of the ovary is often enormous, and to such an extent that the organ has been found weighing fifty-five,(2) eighty-five, and even one hundred and two pounds.(3)

(1) Stiebel, *Männliches Hymen;* in the *Deutsches Archiv. für die Physiologie*, vol. viii. p. 207.

* Sometimes the supernumerary mammæ exist in unusual parts of the body. Dr. Roberts mentions a woman in whom a third mammæ existed in the groin, with which she suckled several children.

(2) Normand, *Observation sur la transformation d'un ovaire;* in the *Journ. gén. de méd.*, vol. lvi., p. 145.—Valentin, *ibid.*, vol. lviii., p. 218.

(3) Van den Bosch, in Voigtel, *Handbuch der pathologischen Anatomie*, vol. iii. p. 541.

The least abnormal formation of this kind is *dropsy of the ovary*.(1) This state presents some differences. Sometimes, in fact, the liquid is contained in one pouch, sometimes it fills several vesicles, of various sizes. It also differs much not only in respect to quantity, which is often enormous, but also, and even sometimes in the different cysts of the same ovary, in respect to color, consistence, &c.

The cysts generally adhere to the substance of the ovary; but we frequently also find them entirely loose and very numerous in the cavity of this organ, where they seem to have been produced by an effusion of serum. This morbid alteration depends sometimes on the increase of the vesicles of Graaf, sometimes on a repetition of these vesicles resembling the effects of generation, and consequently in a formation of serous membranes.

Not unfrequently these serous membranes contain fat or adipocire.

Beside the serous membranes, accidental mucous membranes are often developed in the ovaries; these also have the form of cysts, contain a more or less dense fluid, and belong to the class of *atheromata* or *melicerides*.

Another alteration in texture of the ovary, which frequently is seen alone or attended with the preceding, is the formation of fibrous, fibro-cartilaginous, cartilaginous, or osseous substance, which is frequently developed in very large rounded masses, and also increases the weight and size of the organ. To this we must refer, if not entirely at least in great part, the formations described as steatoma, sarcoma, scihrrus, osteo-sarcoma, and ossification of the ovary.

To these abnormal repetitions of normal tissues, which frequently occur also in the other parts of the body, but much less commonly than in the ovaries, we must add another, which is almost if not entirely peculiar to these glands. We mean the hairs and the teeth.(2) The hairs are much more frequent than the teeth, and are developed in the fat, and the teeth in the midst of cysts filled with a gelatinous mass, so that here the normal type is perfect, both in respect to the organ where the new formation occurs, as in that of the proportional frequency of its appearance.

The nature of the organ in which these productions of bone, hair, and teeth occur, and which is the workshop of generation, the period of life at which they are most frequently developed, the fact that they have often been preceded by coition, finally the numerous cases of ovarian dropsy, have led many physiologists to consider them as the remains of a fetus which is developed in the ovary. But this hypo-

(1) Fehr, *De virgine, hydrope ovarii laborante*, Strasburg, 1762.—Huth, *Casus virginis hydrope ovarii extinctæ*, Strasburg, 1768.—Murray, *De hydrope ovarii*, Upsal, 1780.—Rossum, *De hydrope ovariorum*, Louvain, 1782.—Julia-Fontenelle, *Analyse de quelques substances contenues dans les ovaires dans certains états morbides;* in the *Archiv. gén. de méd.*, vol. iv., p. 257.

(2) J. F. Meckel, *Mémoire sur les poils et les dents qui se développent accidentellement dans le corps:* in the *Journ. compl. du dict. des sc. méd.*, vol. iv. p. 122 and 217.

thesis is absolutely inadmissible: for the total disparity often observed in respect to number, form, and size, between these abnormal productions, and the remarkable fact that the hair, the bones, and the teeth are the only parts found thus, while in extraordinary pregnancies all the parts of the fetus are long preserved, prove also that the act of generation, if necessary to produce them, has not at least given rise to a perfect fetus, and is confined to developing the parts there found.

Although in many cases the development of these more perfect formations, and also of all the other abnormal formations seen in the ovary, undoubtedly arises from a copulation not sufficient to give rise to a normal organism, on account of the unhealthy state of one or of both the parents, their advanced age, or any other cause which weakens in them the power of generation: we cannot, however, admit that the male is necessary to produce them, since they have been found in very young girls, where the genital organs were perfectly untouched, and they have occurred in other parts of the body not only of the female but in the male.

If they are more common and more perfect in the ovary than in any other of the organs, it is because the formative power is more energetic in this gland. We must not conclude from this that the union of the sexes must necessarily have preceded them, and still less are they the remnant of an ovarian fetus.

The entirely abnormal alterations of texture are much more rare in the ovary, probably for the same cause, and because from the greater energy of the formative power, attempts to create new formations are there more frequently successful.

An extremely rare alteration in respect to form, belonging exclusively to the ovary, and the nature of which has not yet been examined, is a large arborescence, formed of several solid tubercles united by filaments. This anomaly has been observed by Prochaska.(1)

Otto has seen an analogous production, which was not an inch in size.(2)

We also have before us two instances, which are recent. In opening the cadaver of a prostitute aged about thirty years, in whom were traces of an inflammation of the ovary, we found the tubes adherent and very thick, and farther the left ovary considerably enlarged, very soft, and changed into numerous eminences of different figures. In another cadaver of a woman forty years old, on the surface of the right ovary were three cysts about four lines in diameter, the inner face of which was very much folded, and presented similar circumvolutions. The first case was very probably the formation described by Proehaska, which perhaps might have appeared in the second, if the cysts had been torn, and their inner face had vegetated.

§ 2525. Alterations in the texture of the uterus are very frequent.

(1) *Disquis. organism. anat. phys.*, § 58, tab. v.
(2) *Handbuch der pathologischen Anatomie*, p. 378, note 3.

Among the abnormal repetitions of normal tissues we may mention principally the fibrous, fibro-cartilaginous, or osseous bodies, which must be distinguished from schirrus, although they have frequently been described as such, on account of their hardness.

These productions are rounded, sometimes distinct, sometimes united in great numbers, and adhere but slightly to the substance of the uterus. They generally appear on its external, but sometimes on its internal face, and have a yellowish white tint, and an irregular or more or less evidently fibrous structure. They commonly ossify in some parts, although their volume has no effect on this phenomenon. They then become sometimes extremely hard, so that they are cut with difficulty. They are seen principally about the middle of life in unmarried females who have not borne children.

Hairs and fat are formed more rarely under similar circumstances in the substance of the uterus.

All these formations and even the teeth are sometimes developed also on the inner face and in the cavity of the uterus.(1)

The circumstances in which they occur in the last two places allow them to be considered as the imperfect products of generation. Those in the substance of the uterus are most frequently developed without the co-operation of the male, although they may be caused also by copulation. In this respect they resemble the abnormal formations of the ovary. It is very curious that the phenomena caused by them in both organs sometimes resemble those of pregnancy.(2)

Not unfrequently even in these same circumstances other formations are developed in the cavity of the uterus, which may be considered as resulting from an ineffectual effort to produce a new organism, and which resemble either the deciduous membrane, or, when they have the form of thin vesicles filled with a serous fluid, the inner membranes of the ovum.

The entirely abnormal alterations in the texture of the uterus are:

1st. Schirrous and cancerous formations.(3) This alteration does not appear, like the fibrous bodies, in the form of distinct masses; it is formed by a change which generally commences at the lower part of the organ, and which gradually extends to the whole of it. The parts in which it is situated become at first hard, then swell more or less, afterwards suppurate in the same order, and are thus gradually destroyed; abnormal openings are thus formed which communicate with the cavity of the abdomen, the bladder, or the rectum, or with several of these parts at once. Here as in all other cases of this change, the lymphatic system is infected, and death is the necessary consequence.

(1) See our *Handbuch der pathologischen Anatomie*, vol. i. p. 525-542.

(2) Cochon-Dupuis, in the *Mém. de Paris*, 1698, p. 339.—A. Monro, *Four cases of the tumefied ovarium;* in the *Med. essays of Edinb.*, vol. vi., p. 278.—In two cases pains supervened; in the first at nine months, in the other at ten.

(3) Patrix, *Traité sur le cancer de la matrice et sur les maladies des voies urinaires*, Paris, 1820.

All these characters distinguish them from the fibrous and osseous productions.*

2d. Polypi are developed on the inner face of the uterus so frequently that, in twenty cadavers, Portal has found them in thirteen.(1) They are distinguished, according to the place where they exist, into polypi of the base, of the body, and of the neck: and according to their degree of solidity into soft and hard. They vary much in respect to number and volume.

The vagina usually participates in the schirrus of the uterus, at least at its upper part. Polypi also are developed there, particularly at its summit, but much more rarely than in the uterus.

Sometimes hairs grow on the inner face of the external labia.

B. GENITAL ORGANS OF THE MALE.

§ 2526. The alterations in the texture of the testicles are principally:

1st. *Induration*, a consequence of inflammation.

2d. Dropsy of the vaginal tunic, termed *hydrocele*. This disease is common. The liquid is commonly serous and limpid; but sometimes also instead of serum we find a solid and opaque substance, or when this liquid is thicker and more viscous than usual, it contains shining laminæ very similar to the fatty substance of cholesterine, but which differ from it, as their specific gravity is greater, and they dissolve more readily in the alkalies.(2)

3d. Ossification, which is situated principally in the epididymis and the vaginal tunic. We not unfrequently find in the albugineous membrane rounded plates of bone and cartilage, which are finally detached, and become loose in the cavity of the vaginal tunic. These productions are less common in the spermatic cord.

4th. Hairs are very rarely developed in them.

* Very recently the mollescence of the uterus has been made the subject of research. In an article on this subject by Dr. Luroth, we make the following extract in regard to this disease:

He states that mollescence of the uterus is more frequently partial than general; it more commonly occupies the internal surface and the cervix, though it occasionally extends through the substance of the organ. The mollescence presents several degrees, blending insensibly with each other. In the first, the parts are simply softened or very flaccid, generally with serous or sero-sanguineous infiltration into the nterstices. In the second degree, the structure of the uterus is still farther altered. It will scarcely bear handling without reduction into a pultaceous mass. In the third degree, the disorganization amounts almost to a liquefaction or reduction of the viscus to an inorganic pulp.—(*Am. Journ. of the Medical Sciences, for November*, 1828.)

(1) *Observations sur la structure des parties de la génération dans la femme;* in the *Mém. de Paris*, 1770, p. 190.—C. Mayer, *Diss. de polypis uteri*, Berlin, 1820.

(2) Beclard and Cloquet, *Deux observations d'hydrocèles rares;* in the *Bull. de la fac. de méd.*, vol. v. p. 38.

5th. The albuminous and tuberculous formations in the substance of these glands are not rare.

6th. We find also schirrous formations, which change into cancer.

7th. Fungous formations.

8th. Cysts filled with a liquid similar to the serum of the blood.

Sometimes, but rarely, calculi form in the seminal vesicles,(1) or in the prostate gland.(2) The latter at least are composed of phosphate of lime.

The alterations in the texture of the penis are usually of syphilitic origin, ulcers, warts, &c.

C. MAMMÆ.

§ 2527. The mammæ of the male are subject to but few diseases. The alteration most frequent in those of the female is schirrus. We however designate by this term new formations, however much they differ, for almost all can be developed either alone or with others, in the tissue of the mammary gland.*

CHAPTER V.

OF THE ABDOMINAL CAVITY.

ARTICLE FIRST.

ABDOMINAL CAVITY IN THE NORMAL STATE.

A. PERFECT STATE.

I. ABDOMINAL CAVITY IN GENERAL.

§ 2528. After describing the digestive, the respiratory, the urinary, and the genital systems, we proceed to the topography of the abdominal cavity,(3) the general characters of which have already been mentioned.(4)

(1) Hartmann, *De calculis in vesicula seminali*, Erfort, 1765.

(2) Pohl, *De calculis in prostata inventis*, Leipsic, 1737.

* An abnormal formation in the mammæ which is not common is that of hydatids, one case of which is detailed in the *Am. Journ. of the Medical Sciences for November*, 1825.

(3) Fantoni, *De musculis abdominis, peritonæo, vasis ombilicalibus et omento*, Turin, 1745.

(4) Vol. i. p. 151.

A. COMPOSITION.

§ 2529. The *upper* wall is formed by the diaphragm; the *posterior*, in the centre, by the lumbar vertebræ and the sacrum, on the sides by the psoas magnus and the posterior part of the two broad internal abdominal muscles: each side is constituted above by the middle portion of these two muscles, and the posterior part of the obliquus abdominis externus, below by the ossa ilia and the descending ramus of the ischium, the *anterior* by the anterior part of the broad abdominal muscles, the rectus, the pyramidalis, the linea alba, the pubis, and its ascending ramus. The *inferior* by the muscles of the perineum.

The parts we have mentioned are covered on the inside directly or indirectly by the peritoneum.

Hence the abdominal parietes are most solid in the posterior and inferior parts. We may judge also from the description of the muscles which form them, that these also are enveloped in some parts more perfectly than in others. In the latter, the muscular layers are thinner and more feeble, or the muscles and their tendons are here entirely or in great part deficient.

B. FORM.

§ 2530. Considered generally, the form of the cavity of the abdomen is oval. The umbilicus is situated at about the centre of its anterior face: the half above this cicatrix is a little larger and broader than the lower. The anterior wall is the longest. The sides are very short and almost straight. The posterior presents inequalities produced by the projection of the lumbar vertebræ and the sacrum. It is convex in the centre, at its upper part, and concave on the sides, particularly below. The upper and lower faces are more or less concave.

C. DIMENSIONS.

§ 2531. The abdominal cavity is much larger than the thoracic: it is the most extensive of the three splanchnic cavities.

D. CHANGES IN FORM AND SIZE.

§ 2532. As its parietes are formed mostly by muscles, it can vary much in form and size. The most important change is that which occurs regularly and constantly during respiration, and which depends on the alternate contraction and relaxation of the diaphragm. The action of the abdominal muscles also occasionally contract it more or less, to expel the substances contained in the intestinal canal, the uterus, and even in the bladder. The diaphragm and the other abdo-

minal muscles are generally antagonists. Their simultaneous action exerted in straining,(1) produces the greatest possible contraction.

The abdominal cavity is unusually distended:

1st. By every thing which normally or abnormally increases the mass or the volume of the parts it contains.

2d. By the direct accumulation within it of substances of every kind, the origin of which varies infinitely.

In this case all the parts which form its parietes are generally uniformly distended.

§ 2533. Besides the organs we have mentioned above, the abdominal cavity also contains the lower part of the aorta, the ascending vena-cava, the commencement of the thoracic canal, the great iliac trunks, the lower part of the ganglionnary nerve, and the lumbar and iliac plexuses of the last spinal nerves.

All these parts are attached more or less by cellular tissue and in a larger or smaller part of their parietes, especially with the posterior, less to the superior, still less to the inferior, the anterior, and the lower region of the side; the upper region of the selatter and of the anterior, is entirely loose, except a small portion of the anterior, to which the suspensory ligament of the liver is attached.

Even where there is no continuity between the containing parts and those contained, the external faces of these latter are in direct contact with the internal face of the abdominal parietes, so that these faces can glide or play upon each other.

As to their situation, the parts contained in the abdominal cavity differ principally in this respect, that most of them, viz. the upper region of the genital system of the female, and the whole digestive apparatus except the pancreas and the lower extremity of the rectum, are contained in the peritoneum, while the others, especially the great vascular and nervous trunks, the urinary organs and the lower part of the genital system, are situated out of this membrane.

II. PERITONEUM.

§ 2534. The *peritoneum*,(2) the largest and the most complex serous membrane in the body, has a fibro-serous structure in some parts. It forms a sac, closed in every part except at the abdominal orifices of

(1) J. Cloquet, *De l'influence des efforts sur les organes renfermés dans la cavité thoracique*, Paris, 1820.

(2) Wedel, *De peritonæo*, Jena, 1696.—J. Douglas, *Description of the peritoneum and of that part of the membrana cellularis which lies on its outside, with an account of all the abdominal viscera*, London, 1730.—C. G. Buttner, *De peritonæo*, Konigsberg, 1738.—F. G. Hewsing, *De peritonæo*, Giessen, 1742.—H. A. Wrisberg, *De peritonæo diverticulis, illisque imprimis, quæ per ombilicum et lineam albam contingunt*, Gottingen, 1780.—A. Vacca-Berlinghieri, *Mémoire sur la structure du peritoine et sur ses rapparts avec les viscéres abdominaux;* in the *Mémoires de la soc. méd. d'émul.*, vol. iii. p. 315.—C. J. M. Langenbeck, *Commentarius de structurâ peritonæi, testiculorum tunicis, eorumque ex abdomine in scrotum descensu, ad illustrandam herniarum indolem*, Gottingen, 1817.

the two Fallopian tubes, where it is continuous with the mucous membrane of these passages. It covers almost the whole cavity of the abdomen, except at the lowest part of the pelvis, and like all the serous membranes, it covers in two different modes the parts on the surface of which it passes. In fact, 1st, it envelops them all with its external layer, which has the form of a sac, but does not touch them; 2d, Its inner layer is reflected in several places, and is fitted to the surface of the parts, and forms their external envelop.

Several anatomists assert, that not only the parts enumerated above, but also all those situated in the abdomen, are contained in the peritoneum, which divides into an external and an internal layer to embrace them. This opinion arises from another, that the condensed cellular tissue on the outer face of the peritoneum, is a special fold of this membrane. But we cannot admit it, since this layer is not serous; it exists in every part; it does not come from the division of the proper serous fold of the peritoneum, but it is formed by the scalpel, particularly when the parts are hardened by immersion in alcohol.

§ 2535. Like all serous membranes, the peritoneum is highly extensible, so that it does not tear when suddenly or gradually extended very much. Its solidity in the normal state depends upon this property.

It is not equally firm in every part. The external layer is generally much stronger and thicker than the internal. It is strongest in the lumbar region, and at its lower and anterior part, and is weakest at its upper part.

As its connections with the abdominal parietes are generally slight, it yields easily when drawn down, so that its situation and its relations with the adjacent parts change in a greater or less extent, when the testicles descend into the scrotum, or when a hernia exists.

A. EXTERNAL FOLD OF THE PERITONEUM.

§ 2536. We may distinguish in the external fold of the peritoneum, four parietes, an anterior, a superior, a posterior, and an inferior, the external faces of which are almost in every part united to the internal face of the abdominal parietes.

A. ANTERIOR WALL.

§ 2537. The anterior wall covers the posterior face of the linea alba, the common anterior tendons of the broad muscles of the abdomen, and the anterior part of the fleshy portion of the transversalis muscle. It is attached rather loosely to the linea alba, adheres intimately to the anterior tendon, and is connected less firmly with the fleshy portion of the transversalis muscle. It is serous only at its lower part: but above it is covered on the outside by a very apparent layer of transverse and strong fibres, entirely distinct from those of the tendons

of the transversalis abdominis muscle, and of the linea alba, and which terminate near the umbilicus by a semicircular edge.

From the bladder to the umbilicus the urachus passes over its internal face, on the sides of which we observe the remains of the umbilical arteries, which separate below, are united in a single cord at their upper part, penetrate from without inward, and thus produce on the inside the prominences which have been called *prolongations of the peritoneum* (*processus peritonei*).

On the inner face of the anterior wall we remark the *suspensory ligament of the liver* (*L. hepatis suspensorium*) which descends from right to left to the umbilicus. It is a considerable triangular fold, expanded like a fan, the posterior edge of which is attached from before backward to the upper face of the liver, where it separates the right from the left lobe, and in the lower and loose edge of which we distinguish the *round ligament of the liver* (*L. hepatis teres*), which extends from the umbilicus to the liver.

B. SUPERIOR WALL.

§ 2538. The posterior wall covers the lower face of the diaphragm, to which it is loosely attached.

Near the posterior edge of the muscle the peritoneum is reflected to the right on the liver, and not only covers the whole of this viscus, but also when it comes to the fissure of the vena-portæ, where it forms as it were a sheath, the fasciculus formed by the union of the hepatic artery, the vena-portæ and the biliary passages, goes on the upper part of the duodenum, to be continuous there with the small epiploon, the great epiploon, and the transverse mesocolon.

The very short fold between the blunt edge of the liver and the upper wall of the peritoneum, is termed the *coronary ligament of the liver* (*L. hepatis coronarium*).

From the right side, between the union of the posterior edge of the liver with the anterior, and the limit of the posterior, superior, and anterior walls of the peritoneum, we perceive a larger fold, which is the *right triangular ligament of the liver* (*L. hepatis triangulare dextrum*).

A similar but much larger fold extends from the posterior edge of the small lobe of the liver, and from its summit, to the posterior wall of the peritoneum; it is the *left triangular ligament of the liver* (*L. hepatis triangulare sinistrum*), which is continuous forward with the superior ligament of the organ.

In the place where the esophagus passes through the peritoneum, in proceeding through the esophageal fissure of the diaphragm, this membrane covers it in every part, and also in the upper part of the stomach. The folds which result from them are termed the *right* and *left phrenico-gastric ligaments* (*L. phrenico-gastricum, dextrum*, and *sinistrum*). The first is continuous with the small epiploon, and the

second with the *suspensory ligament of the spleen* (*L. lienis suspensorium*), which is situated more to the left, between the upper extremity of the spleen and the posterior edge of the upper wall of the peritoneum.

C. POSTERIOR WALL.

§ 2539. The posterior wall descends from the upper and posterior edge of the liver, from the cardiac orifice of the stomach, from the left portion of the small curve of this viscus, and from the upper extremity of the spleen, above the lumbar portion of the diaphragm, then leaves the posterior wall of the abdominal cavity, and goes on the anterior face of the pancreas and duodenum, to which organs it adheres very slightly. After leaving the lower edge of the pancreas, the peritoneum goes downward and forward, and forms the upper layer of the transverse mesocolon, a broad and considerable fold, which receives anteriorly the transverse colon between its two layers, and the inferior layer of which is continuous with the lower part of the posterior layer.

This lower part descends before the aorta, the vena-cava, and the kidneys, to which organs it slightly adheres, and afterwards goes without forming any fold, on the right or left, or at least without producing any except those which are very small, on the ascending and descending portions of the colon, goes also to the right side of the kidney towards the duodenum, the anterior face of which it covers, intimately uniting this whole intestine with the upper extremity of the ascending colon, and after covering all these parts, is continuous with the anterior wall, on the posterior portion of the transversalis abdominis muscle.

Only the lower part of the descending colon and the commencement of the rectum, form a considerable fold on the central part of the psoas magnus muscle, and on the upper part of the sacrum.

In the centre of the posterior wall is a fourth fold, directed obliquely from left to right, it descends from the second lumbar vertebra, and is termed the *mesentery* (*mesenterium*). This fold, the root of which is very narrow, enlarges much at its loose edge, which embraces all the small intestine except the duodenum. It is continuous below with the right mesocolon, and gives off a small triangular prolongation, which serves as a mesentery to the vermiform appendage of the cœcum.

It is continuous above with the centre of the transverse colon.

In this place the two layers of these folds separate, and receive between them the lower part of the duodenum.

D. INFERIOR WALL.

§ 2540. We may consider as the lower wall of the external fold of the peritoneum, the part of this membrane which corresponds to the pelvic region of the abdominal cavity, and term it the *pelvic portion.*

It is attached very loosely to the iliaci muscles, to the lower part of the abdominal muscles, to the levator ani muscle, and the sacral plexus. It is connected forward with the obturator internus muscle and the posterior face of the bladder. It covers posteriorly the upper part of the sacrum, but does not adhere to it strongly, and is reflected inward on the upper part of the rectum.

It covers below in the two sexes, the inner part of the levator ani muscle, to which it is loosely united.

The anterior and posterior halves of this lower wall of the peritoneum, are adapted to each other, between the bladder and the rectum, so that in the male the anterior passes from the bladder upon the seminal vesicles, but does not touch them, and in the female, from the bladder upon the upper part of the vagina, and the lower part of the uterus, which it loosely envelops. Having thus arrived backward, it reunites to the posterior, which comes from the rectum, forming a greater or less cul-de-sac between this intestine and the parts we have mentioned.

This cul-de-sac is limited on the right and left by two longitudinal folds, which extend in the male from the rectum to the lower part of the bladder, in the female from the intestine to the lower part of the uterus, and are termed the *semilunar folds* (*plicæ semilunares*).

These folds are much smaller, and consequently the cul-de-sac is much less distinct from the rest of the peritoneal cavity, the more the rectum and the bladder, or the uterus are distended, because then the peritoneum is enlarged to cover its parts.

The lateral wall of the pelvic portion of the peritoneum, forms in the small pelvis of the female a considerable fold, termed the *broad ligament of the uterus* (*L. uteri latum*). This fold is attached to the upper part of the vagina, to all the lateral wall of the uterus, to the Fallopian tubes, and to the ovaries, closely covers these parts, and lodges between its two folds the vessels and nerves which go to it.

The most important part of the pelvic portion of the peritoneum, is that included between the inner extremity of the iliac crest and the symphysis pubis.(1)

The peritoneum forms in this place two depressions, which are separated by the umbilical ligament, and by the prolongation of the

(1) Hesselbach, *Ueber den Ursprung der Leistenbrüche*, Wurzburg, 1806.—Id., *Ursprung und Fortschritte der Leisten-und Schenkelbrüche*, Wurzburg, 1816.—Id., *Disquisitiones anatomico-pathologicæ de ortu et progressu herniarum inguinalium et cruralium*, Marburg, 1816.—R. Liston, *Memoir on the formation and the connections of the crural arch and on the parts contained in inguinal and crural hernia*, Edinburgh, 1819.

peritoneum which surrounds it, and which may be termed the *inguinal fossæ;* they are distinguished into *external* and *superior*, the large, and *internal* or *inferior*, the smaller. At the place where the inguinal canal commences, we usually observe in the peritoneum a small depression, which is often connected with a cord formed of cellular tissue, which passes through this canal. This depression frequently forms a greater or less sac. It is always a remnant of the prolongation which formerly extended from the peritoneum into the scrotum.

The external inguinal fossa represents a pyramid, situated between the peritoneal prolongation and the commencement of the inguinal canal. The internal is adapted on the median line to that of the opposite side, from which it is always more or less completely separated by the projection of the urachus. It corresponds directly to the inguinal ring.

B. INTERNAL FOLD OF THE PERITONEUM.

§ 2541. The internal fold of the peritoneum which covers the outside of the parts situated in the cavity of the abdomen, is much thinner than the external. It is not arranged exactly in the same manner in regard to all the parts it covers, for it is attached directly to some, and to others only by more or less considerable prolongations. In several portions it extends on the almost loose part of the surface of the organs, and forms prolongations, which are sometimes loose and floating, and sometimes contribute also to unite one organ with another, independent of the common envelop.

All these internal prolongations of the peritoneum, whatever be their relation with the organs, are formed of two layers, all the corrugated faces of which adhere to each other, while the smooth faces are loose and turned outward. We may then term them generally the *folds of the peritoneum.*

The folds between the external layer of the peritoneum and the intestinal canal, are termed the *mesenteries* (*mesenteria*).(1)

Those which are shorter but broader, and which exist between the external fold of the peritoneum and the other parts, particularly the stomach, liver, spleen, &c., are termed the *ligaments of the peritoneum* (*L. peritonei*). Their names are derived sometimes from their form, and sometimes from the parts which they unite. We have already mentioned most of them, in describing the external layer: and shall return to them when speaking of the epiploon.

The folds which extend from one viscus to another, are the *epiploa* (*omenta*, s. *epiploa*).(2)

(1) J. S. Henninger, *De mesenterio*, Strasburg, 1714.—J. Fantoni, *De mesenterio, vasis chyliferis et lymphaticis;* in the *Diss. anat. renov. V.*—Stock, *De statu mesenterii naturali et præternaturali*, Jena, 1755.—M. Malpighi, *De omento, pinguedine et adiposis ductibus;* in *Opp. omn.*, vol. i. p. 227

(2) Henrici, *Diss. sistens novum descriptionem et iconem omenti*, Copenhagen, 1738.—Haller, *Omenti nova icon.;* in the *Icon. anat. fasc. I*, and *opp. min.*, vol. i.—

Those which only project on the surface of a viscus, are termed the *epiploic appendages* (*appendices epiploicæ*).

The last two kinds of folds differ from all others, as they are extremely thin, so that many anatomists have even considered their reticulated or perforated structure as a normal arrangement.

A. MESENTERIES.

§ 2542. The best mode is to commence the history of the folds of the peritoneum by that of the mesenteries.

a. Mesentery.

§ 2543. The *proper mesentery* (*mesenterium*) is directed obliquely from above downward, and from right to left; it extends from the left side of the body of the second lumbar vertebra, to the right sacro-iliac symphysis.

It is composed of two layers, a right and a left, which are separated in the upper two thirds of the mesentery, by the third or the ascending portion of the duodenum, but which unite beyond this portion, and in the lower third of the mesentery.

The posterior edge, which rests on the vertebral column, is termed the *root of the mesentery* (*radix mesenterii*). It is much shorter than the anterior, by which it is attached to the small intestine, so that its layers separate on arriving at the intestine, which they receive between them, and narrowly embrace them in all their extent.

The mesentery enlarges imperceptibly from its upper and lower parts, to its centre. Its greatest breadth is about four inches.

Between the two layers which compose it, and which are easily separated, are cellular tissue, fat, lymphatic ganglions, blood-vessels, lymphatic and chyliferous vessels, and nerves.

It is continuous at its upper extremity with the transverse mesocolon, at the lower, with the triangular mesentery of the vermiform appendix of the cœcum, which is attached to the left side of its circumference, and the left side of which is perfectly loose, and continuous with the ascending mesocolon.

b. Mesocolon.

§ 2544. The colon is not, like the small intestine, attached to the posterior wall of the abdominal cavity by a very long fold, which per-

Reebmann, *De omento sano et morboso*, Strasburg, 1753.—P. Van Nœmer, *De fabrica et usu omenti*, Leyden, 1764.—Chaussier, *Essai sur la structure et les usages des épiploons*; in the *Mém. de l'ac. de Dijon*, 1784.—Froriep, *Neue Darstellung der Gehroses und der Netze*, Weimar, 1812.

mits it to float freely. On the contrary, it is atttached more firmly and immovably by the mesocolon.

After covering the centre of the duodenum on the right side, the posterior wall of the peritoneum goes on the ascending portion of the colon, and covers it anteriorly, but not posteriorly, or at least but very rarely, where it is exposed on the anterior face of the kidney. Even when the ascending colon is entirely enveloped by the peritoneum, the fold which attaches it is always very short.

The cœcum is most generally attached rather more loosely to the upper part of the iliacus muscle.

There are often detached from its summit two triangular folds, directed from right to left, and from above downward, which leave between them a depression, the base of which is formed by the iliacus muscle and the cœcum, and into which, particularly when the cavity is considerable, a greater or less portion of the intestine enters and is strangulated.

The *transverse mesocolon* (*mesocolon transversum*), which is uninterruptedly continuous with the ascending mesocolon, is an elongated quadrilateral fold, about four inches high, which extends from right to left near the centre of the abdominal cavity, and which is much higher in the centre than on the sides.

It arises on the right from the centre of the duodenum, in the centre from the anterior face of the pancreas, often also from the right side of the posterior face of the stomach, farther, and towards the left, from the extremity of the duodenum, and is attached to the transverse colon by its anterior edge.

At its commencement on the right on the duodenum, it is continuous above and below with the portion of the posterior wall of the peritoneum, which covers the duodenum anteriorly, and intimately unites this intestine to the colon.

Farther on the right, its upper layer closely unites with a greater or less portion of the great epiploon, so that hence, a quadruple layer from the duodenum to a greater or less portion of the right half of the great curve of the stomach exists, and this union of the right edges of the great epiploon and transverse mesocolon, always closes in this place the sac formed by these two folds.

It imperfectly divides the internal fold of the peritoneum into two halves, a superior, smaller, and an inferior, which is larger.

The *descending mesocolon*, the direct continuation of the preceding, is quadrilateral at its upper part, and does not generally surround the whole circumference of the descending colon. It arises from the upper part of the anterior face of the left kidney, but comes also in its centre, where it is more extensive, from the anterior fold of the posterior tendon of the transversalis abdominis muscle, finally below where it is larger than in any other part, and often also as broad as the transverse mesocolon, from the left psoas muscle and the sacro-iliac symphysis of the same side.

A small part of the upper portion of the rectum is attached to the anterior face of the sacrum by a short fold of the peritoneum, termed the *mesorectum*.

B. EPIPLOA.

a. Great epiploon.

§ 2545. The *great epiploon*, *epiploon gastro-colique*, descends by its upper edge:

1st. From the lower part of the fissure of the spleen, and from its lower extremity, where it is united with the gastro-splenic ligament.

2d. From all the great curve of the stomach.

3d. From the commencement of the duodenum.

It is adapted to the anterior part of the circumference of the transverse colon, goes before the small intestine, and generally descends into the pelvis, where it terminates by a loose edge.

Its straight edge unites with the transverse mesocolon, and is attached by the left to the lower extremity of the spleen, and also to the left extremity of the pancreas and the transverse colon, uniting with the posterior wall of the peritoneum.

b. Small epiploon.

§ 2546. The *small epiploon*, *epiploon gastro-hepatique* (*epiploon hepatico-gastricum*), descends from the fissure of the venous canal, from the left portion of the fissure of the vena-portæ, and the capsule of Glisson, towards the small curve of the stomach, from the cardiac to the pyloric orifice, and floats before the lobe of Spigel.

The two epiploa communicate by the portion of the peritoneum which covers the anterior and posterior faces of the stomach, and thus forms, with the stomach, the anterior wall of a sac, the lower wall of which is constituted by the transverse colon and the transverse mesocolon, and the posterior by the upper part of the posterior wall of the peritoneum.

The upper part of this sac, which is placed between the liver and the small curve of the stomach, communicates with the inferior, situated between the small curve and the transverse colon, by a greater or less opening, which is found between the posterior wall of the stomach and that of the peritoneum, in the part where the small curve of the stomach, near its right extremity, is not attached to the posterior wall of the peritoneal sac.

The whole sac or the cavity of the epiploon communicates with the peritoneal cavity by the *foramen of Winslow* (*foramen Winslowii*), a rounded, oblong opening, situated on the right side of the abdomen, bounded on the right by the fissure of the vena-portæ, forward by the

fasciculus formed by the vena-portæ, the hepatic artery, and the biliary passages, on the left by the first curve of the duodenum, and below by the posterior wall of the peritoneum, which the ascending vena-cava covers in this place.

When we separate the liver and duodenum, and consequently remove from this latter organ the portion of peritoneum which extends from its summit to the liver, in forming a sheath around the fasciculus we have mentioned, a more or less broad, semicircular fold is formed, having its loose edge turned downward; this is termed the *hepato-duodenal* ligament (*L. hepato-duodenale*).

We may produce also in the same manner an analogous fold between the first curve of the duodenum and the upper extremity of the right kidney. This last fold is the *duodeno-renal* ligament (*L. duodeno-renale*).

The foramen of Winslow is situated between these two folds.

c. Epiploic appendages.

§ 2547. The *epiploic appendages* (*Appendices epiploicæ*) are short prolongations of the peritoneal tunic of the large intestine; they are rounded, oblong, varying in breadth, filled with fat in fleshy people, and with a reddish, gelatinous liquid in lean persons. They arise principally from the anterior side of the edge of this tunic.

They are observed along the whole length of the colon, but they are not arranged exactly in the same manner in all parts of this intestine.

They always receive a considerable vascular branch, which comes from the mesocolon.

They are generally arranged in two rows.

These rows are situated on the outside and the inside of the intestine in the lower portion of the descending colon, on the lower edge in the transverse colon, finally on the internal and anterior edge in the descending colon.

In this latter point one of the two rows, the longest, is much nearer the intestinal extremity of the mesocolon than in the ascending colon.

In the ascending colon, the epiploic appendages receive the external and internal branches of the mesenteric vessels. In the rest of the colon their vessels come only from the lower and internal branches of those of the intestine.

The mesocola form also at intervals near the intestine similar prolongations, which are directed from above downward.

B. PERIODICAL DIFFERENCES.

I. REGULAR AND GENERAL DIFFERENCES.

§ 2548. 1st. The abdominal cavity is much larger in proportion to the chest, during the early periods of existence, than when the subject is fully grown, but its pelvic portion is infinitely smaller.

2d. Until the third month of pregnancy it extends by means of a prolongation, the length and the breadth of which are in direct ratio with the youthful age of the new being, and which incloses a portion of the intestinal canal, with the umbilical and omphalo-mesenteric vessels, in the umbilical sheath formed by the inner membrane of the ovum, so that this sheath then really makes part of it. The anterior cavity is covered by a prolongation which is also reflected on the viscera which it contains.

In the fetus of three months, the anterior wall of the peritoneum extends already on the opening of the umbilicus, through which the umbilical vessels enter and depart, but does not give off in this place a prolongation which penetrates into the cord.

We do not perceive at first any well marked difference between the general ligaments and the umbilical sheath; but this difference is seen in proportion as the development of the skin progresses. Hence in the full-grown fetus the root of the umbilical cord is surrounded by a cylindrical fold of skin, which is about four lines long, and is usually more distinct from the umbilical sheath on the right side than the left,(1) the inner face of which is strengthened by some fibres of the linea-alba.

The umbilical ring is much broader the younger the fetus is. It gradually contracts, and in the full-grown fetus it exactly surrounds the umbilical vessels. Its lower part particularly is intimately united with the umbilical artery by a short and firm cellular tissue; the cellular tissue which unites the upper with the umbilical vein is looser. The umbilical ring is already surrounded in the full-grown fetus with very strong and perfectly developed tendinous fibres, while the linea alba, less advanced in all these respects, is formed only of indistinct and proportionally shorter and narrower tendinous fibres.

After birth the portion of the cord left on the body of the infant dies in its whole extent where it is covered by the umbilical sheath. Instead of the cylindrical fold of skin, there forms a depressed cicatrix, the *navel* or *umbilicus*, the depression of which depends principally on the disappearance at this period of the prominence previously formed by the umbilical vessels and the gelatine of Wharton.

(1) Sœmmerring, *Ueber Nabelbrüche*, Frankfort, 1811, p. 7.

It depends also on the general law that the cicatrices of the skin are attended with a greater or less contraction. The collapsing of the umbilical vessels also assists to form it. Afterward the depression increases as much more as there is fat deposited in the surrounding parts, for this fluid never accumulates in the cicatrix.

The umbilical ring and the peritoneum gradually adhere very intimately with the cellular tissue and the skin which covers them. In the book on embryology we shall mention the changes in the umbilical vessels.

3d. In the male and female fetus, the peritoneum forms another culde-sac, the *diverticulum of Nuck* (*diverticulum Nuckii*), which extends through the inguinal canal and inguinal ring. This diverticulum is connected with the development of the testicle in the male. It has even the same use in the female, but as it here receives no organ it is much narrower and shorter, and often disappears before the end of the last month of pregnancy.

The great epiploon appears in the second month of pregnancy. Until the fourth there exists only a simple prolongation of the peritoneal coat of the stomach, which is not yet connected with the transverse colon.

The epiploic appendages of the large intestine appear at the fifth month of pregnancy.

II. ACCIDENTAL DIFFERENCES.

§ 2549. The abdominal cavity is considerably distended during pregnancy: but it returns almost entirely to its normal dimensions after parturition. We have not observed any marked difference either in the region of the umbilicus or in other parts, even in those females who have had several children, nor has Sœmmerring.(1) But the skin being much less extensible, wrinkles are formed in the general integuments of the abdomen by pregnancy, which are not seen in females who have had no children.

C. DIFFERENCES RELATIVE TO SEX.

§ 2550. The abdominal cavity is smaller in proportion to the chest in the male than in the female, in whom it is much longer and narrower at its upper part, but much broader in the lower, that is, in its pelvic portion. The hairs of the pubis also differ in their arrangement. In fact in females they suddenly cease, and occupy only the centre of the space between the umbilicus and the symphysis pubis, while in the male they extend in a point to the umbilicus.

(1) *Loc. cit.*, p. 25.

ARTICLE SECOND.

OF THE ABDOMINAL CAVITY IN THE ABNORMAL STATE.

A. DEVIATIONS OF FORMATION.

§ 2551. 1st. When the upper half of the body is not perfectly developed, in acephalia vera, the abdominal cavity presents more or less the same deviation of formation at its summit, so that sometimes only the pelvic portion exists, and this also is frequently narrower than in the normal state.

In other cases, on the contrary, tumors, congestions, liquids, &c., often distend it very much.

2d. Curvature of the spine, which sometimes, but very rarely, constitutes a primitive deviation of formation, naturally causes a greater or less alteration in the form of the abdominal cavity and the situation of the parts within it.

3d. This cavity not unfrequently presents anomalies depending on the permanence of one of the degrees of formation through which it successively passes, that is, the openings and prolongations first existing at its upper or lower extremity do not disappear in a greater or less portion of their extent. This causes congenital umbilical hernia, and the abnormal communication between the vaginal tunic of the testicle and the cavity of the peritoneum, which give rise to congenital inguinal hernia.

Frequently also the connections of the abdominal parietes with the parts contained in this cavity, particularly those of the external and internal layers of the peritoneum, are abnormal.

This abnormal state is sometimes, but rarely, the effect of a primitive deviation of formation. It is generally consecutive.

It is much more common to observe unusual connections, adhesions, which are generally the consequence of an inflammation of the peritoneum, and which are caused by effusion. Sometimes even in this case all the organs surrounded by the peritoneum are so blended in one mass that they cannot be perfectly separated; but they generally adhere only in some parts.

Solutions of continuity are very rare, and generally constitute primitive deviations of formation.

If the adhesions occur so that they produce a kind of bridge between the two parts, this arrangement may induce in the cavity of the abdomen the same consequences as certain solutions of continuity, as an opening also results from them; but this is a subject naturally connected with that of internal hernias, of which we shall speak hereafter.

4th. The abdominal viscera are not unfrequently displaced. Most of these displacements are termed *hernias*,(1) which term includes every abnormal situation of a viscus which leaves the cavity in which it is normally situated, or which enters into a generally abnormal compartment of the cavity in which it is situated.

The first case constitutes the *external*, and the second the *internal* hernias.

I. EXTERNAL HERNIAS.

§ 2552. The most important points in the history of hernia are, the relations of the displaced parts with the integuments, the nature of the herniary parts and the changes in them, finally the place where the hernia occurs, and the peculiar phenomena presented by each species of hernia in the first two respects.

1st. *Nature of the envelops.* Beside the integrity of the common integuments, which occurs first in most hernias, the most general condition of this anomaly is the existence of a herniary sac, produced by the elongation of the peritoneum.

The internal hernias differ in this respect from the external: for the parts which have passed through an abnormal opening in the cavity of the abdomen are not surrounded with a herniary sac. Besides sometimes we find no sac in the external hernias, whither it has never existed, as when the peritoneum is torn, or it has been destroyed by compression, suppuration, gangrene.

The herniary sac is principally deficient in phrenic hernia, from a rupture of the peritoneum.

On the other hand the peritoneum and the cellular tissue which surrounds it externally gradually thicken and become harder to some extent, particularly at the entrance or neck of the herniary sac, which happens particularly after long compression.

Not unfrequently also inflammations arise from the prolongations which extend from one point of the circumference of the herniary sac to the others.

(1) J. G. Gunz, *Observationum anatomico-chirurgicarum de herniis libellus*, Leipsic, 1744.—G. Vogel, *Abhandlung aller Arten der Brüche*, Leipsic, 1756.—P. Pott, *Treatise on ruptures*, London, 1756.—J. T. Klinkosch, *Programma quo divisionem herniarum novamque herniæ ventralis speciem proponit*, Prague, 1764.—Arnaud, *Mémoires de chirurgie*, London, 1768, vol. ii.—A. T. Richter, *Abhandlung von den Brüchen*, Leipsic, 1778.—Monteggia, *Quædam de hernis;* in the *Fasc. anat. path.*, 1793.—J. and C. Wenzel, *Eilf Beobacktungen ueber Brüche:* in Loder, *Journal für Chirurgie*, vol. iii. pt. ii. 1800, p. 217–258.—A. Monro, *The morbid anatomy of the human gullet*, p. 363–542.—J. F. Meckel, *Handbuch der pathologischen Anatomie*, vol. ii. pl. i. p. 358–484.—A. Scarpa, *Traité pratique des hernies*, Paris, 1812–1823.—Lawrence, *Traité des hernies*, Paris, 1818. J. Cloquet, *Recherches anatomiques sur les hernies de l'abdomen*, Paris, 1817–1819.—Breschet, *Essai sur la hernie fémorale*, Paris, 1819.

2d. *Nature of the abdominal organs which form the hernia.* We must consider here the quality of the organs, their state, and their relations with the herniary sac.

a. Hernia is most generally formed by a portion of the small intestine or of the epiploon, more rarely by a portion of the large intestine, still more rarely by the liver or a portion of the urinary or genital organs. We however possess several instances of hernia of the uterus, the ovaries, the Fallopian tubes, and the bladder. An intestinal hernia usually includes all the circumference of the intestine. We rarely find in it only a portion of the surface of the organ.

b. The herniary parts are abnormal, either in respect to their situation only, or also in their functions and texture. This latter case happens particularly when, from a want of proportion between the capacity of the herniary sac and the volume of the part displaced, this latter is compressed, strangulated, whence it inflames, and even becomes gangrenous when the disproportion continues. If gangrene occurs, the herniary portion is separated from that which is contained in the abdominal cavity, which causes, when hernia of the intestine exists, the formation of an abnormal opening termed an *artificial anus.* Some and even large portions of the intestinal canal may be destroyed, although no feces escape into the abdomen, and without the close of the natural opening. This close in fact occurs sometimes from the effusion of fibrin all around the opening produced by the gangrene, which is obliterated at first on the side of the cavity of the intestine, then externally. It occurs even in some cases where there was not the least direct communication between the upper and lower ends of the intestine.

c. The herniary parts do not generally adhere at first to the herniary sac, excepting their envelops, as when, for instance, in the hernias of the ascending or descending colon, the displaced part is primitively united to the sac : but afterward, exsudation which succeeds inflammations of the serous membranes so rapidly, causes the serous membrane of the herniary sac to adhere more or less intimately with the displaaed viscus. The hernia is then said to be *adherent.*

3d. Certain regions of the abdomen are more subject to hernias than others ; particularly those which have a sloping situation, and which on account of their structure, are but slightly resisting. The most common hernias are *bubonocele* and *merocele,* which take place, one through the inguinal ring, the other through the crural arch. The inguinal hernias become *scrotal* when these viscera descend into the scrotum. The bubonocele is more common in males, and the merocele in females. Next come the *umbilical* hernias, then the *ventral,* next those through the *foramen ovale,* then the *phrenic,* and lastly the *ischiatic* and the *lumbar.*

a. In *inguinal* hernia, the viscera always emerge through the inguinal ring, but do not always come there in the same manner. In the *external* or *oblique* inguinal hernia, which is infinitely more common than the other, the viscera emerge through the inguinal anal, so

that the tumor has at first an oblique direction; on the contrary, in the *internal* or *right* inguinal hernia, it proceeds directly from above downward, towards the ring on the inside of the old umbilical artery, and passes through or distends the lower part of the broad internal abdominal muscles which are situated before it. Hence the differences between these two hernias, in respect to their envelops and the relations of the tumor with the adjacent parts.

The external inguinal hernia is inclosed in all the envelops of the spermatic cord, consequently, in the cremaster muscle and the common vaginal tunic. The spermatic cord is situated behind the tumor, and follows the same direction. The epigastric artery is reflected from without inward, and from below upward, behind this tumor. The form of the hernia is oblong, at least at first.

The internal inguinal hernia is not generally enveloped by the cremaster muscle and the vaginal tunic, but only by the cellular tissue of the scrotum. It is situated on the inside of the cord, does not pass before it, and sometimes is found behind it. The epigastric artery ascends at its inner side, and its form is rounder.

Although these differences occur generally, the rule is however subject to exceptions. Thus in one case, the cremaster muscle evidently passed on the anterior face of an internal inguinal hernia.(1) In another case, the spermatic cord proceeded transversely on the neck of an internal hernia, towards its inner side, and farther, near its posterior side.(2) Finally, in a third, the epigastric artery ascended to the inside of the tumor.(3)

Congenital hernia is a variety of external inguinal hernia, in which the viscera descend in the unobliterated prolongation of the peritoneum, and are consequently situated in the same cavity as the testicle, which even sometimes adheres to them before leaving. We must also compare with external inguinal hernia, that recently described as the *infantile* hernia, where the displaced viscera are engaged in the vaginal tube. This hernia may present two forms. Sometimes, in fact, the vaginal tube is open its whole extent, both on the side of the testicle and that of the abdomen, and sometimes only on one side. In the first case the herniary sac does not touch the testicle, as does the organ displaced in congenital hernia. In the second, when the vaginal tube is open at its upper part, the hernia is enveloped by a second sac, which forms it, exactly as in any hernia, the part contained in the sac is by this sac. When, on the contrary, the tube is closed above, the sac occupies also the upper part of the vaginal tunic, but in a still more complex, since this tunic sends to it two envelops, an external and an internal.

The external is arranged as in the second case, and the relations of the vaginal tube are not changed. The internal, on the contrary, is

(1) Todd, *On hernia*; in the *Dublin hospital reports*, Dublin, 1817, vol. i. p. 231.
(2) Ibid.
(3) Hesselbach, *Leisten-und Schenkelbruche*, Wurzburg, 1815, p. 45.

pushed back at its upper part, and reversed by the hernia, whence in this case the sac is smooth externally. We conceive that in all these cases the number of the envelops of the hernia is augmented, and that it is really provided with a double sac. In the first it may be complicated with a common congenital hernia; in the second also, two hernias may coexist.(1)

Inguinal hernia is much more common in the male than in the female, because the inguinal ring is broader in the male, and the vaginal prolongation remains open much longer in him.

b. Crural hernia takes place below the crural arch. It is rounded, and is generally situated on the inner side of the crural vessels, before the epigastric artery, usually also before the obturator artery, even when the latter comes from the epigastric artery, sometimes, however, behind it. Its neck is situated in the male directly below the upper part of the spermatic cord; in the female below the lower part of the round ligament of the uterus. It is more common in the female than in the male, on account of the greater distance between the symphysis pubis and the anterior extremity of the iliac crest.

c. Umbilical hernia occurs either through the umbilical ring, or in its neighbourhood, through a fissure in the linea alba. The first case is the most common when the tumor exists as soon as the child comes into the world, and depends on suspended development. The second is still more so when the hernia is formed there accidentally. It frequently has a rounded form, and is rarely oblong.

d. Ventral hernias are observed principally in the epigastric and the inguinal region, around the ring.

e. Ovular hernia(2) occurs through the space at the upper and outer part of the foramen ovale. It is then situated very deeply before the obturator vessels and nerves, below and behind the adductor muscles of the thigh.

f. Phrenic hernia(3) supervenes in very different parts of the diaphragm, and it is destitute of a sac more frequently than any other hernia. It is congenital much more frequently than accidental, which undoubtedly depends on the necessity of extreme violence to produce it, for since when it occurs the viscera are displaced in a direction opposite to their weight.

g. and *h.* Hernias through the sciatic notch and the lumbar region, are extremely rare. The second has no peritoneal envelop, and is generally formed by the kidneys.

(1) We have enlarged a little on this subject, because it does not seem completely exhausted by Todd's remarks, since the publication of our *Handbuch der pathologischen Anatomie*, vol. i. pt. 2. p. 416.

(2) Buhle, *De herniâ obturatoria*, Halle, 1819.

(3) Zwanziger, *De herniâ diaphragmaticâ*, Halle, 1819.

II. INTERNAL HERNIAS.

§ 2553. The *internal hernias*(1) are occasioned by abnormal openings, or by culs-de-saç existing in the cavity of the abdomen.

1st. Abnormal openings exist sometimes in the internal portion of the peritoneum, that which always occurs, and sometimes form after partial adhesions between parts which should be separated.

The openings of the first kind, which are more rare, occur principally in the mesentery.(2)

Those of the second class may be developed in all parts. We have observed almost all of them in cadavers. The partial adhesions which give rise to them, may take place,

a. Between several portions of the intestine.

b. Between the small intestine and the anterior edge of the liver.

c. Between the upper face of the liver and the upper wall of the peritoneum.

d. At the summit of a diverticulum of the ileon, especially by a filament which still exists there, and which is formed by the remnant of the omphalo-mesenteric vessels.(3)

e. Between the vermiform appendix of the cœcum and a portion of the mesentery, the intestinal canal, and the uterus.(4)

f. Between the epiploon and the base of the uterus, or any other abdominal organ, or even the parietes of the peritoneum. It is the most common of all the adhesions.(5)

g. Between the ovary, especially when it is enlarged, and the base of the uterus.

2d. Abnormal depressions are formed by the mesentery,(6) the bladder,(7) the vagina.(8) In the last case the bladder is situated in the wall of the vagina, particularly the anterior, which is then turned over.(9)

(1) Meyer, *De strangulationibus intestinorum in cavo abdominis*, Strasburg, 1776.

(2) Heuermann, *Chir. operat.*, vol. i. p. 627.—Saucerotte, in the *Mém. de l'ac. de chir.*, vol. iv. p. 239.—Monro, *Anat. of the gullet*, p. 537.

(3) Van Dœveren, *Annot. acad.* V.—Monro, *loc. cit.*, tab. xx. p. 538.

(4) Monro, *Phys. essays of Edinb.*, vol. ii. p. 402.—Otto, *Pathol. Anat.*, p. 280.

(5) Ruysch, *Obs. anat.*, 65.—Monro, *Anat. of the gullet*, p. 533.—J. P. Weidmann, *Memoria casus rari in gynæccis præcipue adnotandi; cum uteri anticâ facie omenti margo ex aliquâ parte coaluerat; prægnans fœtu, medium graviditatis non assecuta, inopinato moritur*, Munich, 1818.—Gartshore, in the *Med. obs. and inq.*, vol. iv. p. 223.—Haen, *Rat. med.*, pt. ii. c. iii. § 2.—Knoblauch, *Diss. de entero-mesocolocele*, Leyden, 1767.

(6) Neubauer, *Descript. anat. rarissimi peritonæi conceptaculi tenuia intestina a reliquis abdom. visc. seclusa tenentis*, Jena, 1776.—Van der Kolk, *Diss. exhibens observ. varii argumenti*, Groningen, 1793.—Lawrence, *loc. cit.*

(7) Meckel, *Handbuch der pathologischen Anatomie*, vol. ii. p. 467.—Cooper, *Ueber Brüche*, p. 96.

(8) Meckel, *Handbuch der pathologischen Anatomie*, vol. ii. p. 450.

(9) Clarke, *Diseases of females*, tab. iv.

We conceive that these parts, which are then lodged in one of these depressions, can undergo the same changes as in an external hernia.

B. ALTERATIONS IN TEXTURE.

2554. We ought to mention particularly the alterations in the texture of the peritoneum,(1) and which are common to it with the other serous membranes.

This membrane is frequently inflamed in a greater or less extent, and thus more or less broad and firm adhesions are formed. Inflammation of it also produces either in its external or internal layer, an induration, a thickening which is often very great, several lines in extent. This alteration is caused particularly by a long continued inflammation. We may also mention another which depends on the same cause, and is almost peculiar to the peritoneum : it is the development on its inner face, of numerous small miliary elevations.

The abdominal cavity is very frequently the seat of dropsy, which is there called *ascites*. Serum most generally occupies the whole cavity : in some cases only the epiploa are filled.

Sometimes considerable masses of fat are developed on the inner face of the peritoneum, even in persons not very fleshy. The great epiploon particularly, presents frequent instances of this anomaly, and it has then weighed thirty pounds.(2)

Ossifications on the external face of the peritoneum are rare : but we frequently see them at intervals on its internal face, particularly on the surface of the spleen. The epiploon sometimes presents a similar formation.(3)

Rounded, cartilaginous, and osseous masses, similar to those found loose in the articulations, are rarely developed on the inner face of the peritoneum : they finally become loose, leaving their attachments.

Hairs occur in the epiploon still more rarely.

We not unfrequently find on the two faces of the peritoneum, and in the epiploa, serous cysts, and larger or smaller masses of hydatids. The serous cysts also are sometimes detached and become loose.(4)

The external, and more frequently the internal layer, particularly the epiploa and the mesenteries, also are frequently the seat of accidental

(1) J. G. Walter, *De morbis peritonæi*, Berlin, 1787.—Goelicke, *De mesenterii affectibus*, Halle, 1742.—Stock, *loc. cit.*—Reebmann, *loc. cit.*—Halder, *De morbis omenti*, Gottingen, 1786.—A. Portal, *Observations sur les tumeurs et engorgemens de l'épiploon ;* in the *Mém. sur plus. maladies*, vol. i. 1800, p. 67.—Scoutetten, *Mémoire sur l'anatomie pathologique du péritoine ;* in the *Archiv. gén. de méd.*, vol. iii. p. 497; vol. iv. p. 386; vol. v. p. 537.—D. V. Van Leuwen, *De peritonæo ejusque inflammatione*, Utrecht, 1819.

(2) Portal, *Anat. méd.*, vol. v. p. 127.

(3) Mongin, *Sur la pétrification de l'épiploon*, Paris, 1735.

(4) Desbas, *De hydrope peritonæi saccato*, Gottingen, 1761.

formations, of more or less solid whitish substances, which are described as atheromata, steatomata, &c., and which frequently become heavier than the fatty tumors mentioned above.

Ruptures of the reservoirs in the abdomen, produce effusions into its cavity of bile, blood, or of the contents of the intestines or the uterus.

The air which sometimes fills the cavity of the peritoneum, or only that of the epiploa, comes from the same source in some cases. But probably this is not always its origin, for sometimes, although very rarely, this fluid is exhaled by the vessels, the action of which is changed.

BOOK VII.

EMBRYOLOGY.

§ 2555. When all the parts of the body have acquired their respective and normal proportions, and the genital organs also are perfectly developed, the individual is fit to propagate the species by connection with an individual of the other sex. In describing the perfect state of the genital system, we have already mentioned the conditions on the part of these organs, in order that coition may be productive. The connection of the two sexes causes in the female those changes which result in producing a new organism, and which is termed *conception.*(1)

CHAPTER I.

CONCEPTION IN THE NORMAL STATE.

§ 2556. Before detailing the phenomena presented by conception we must establish the following corollaries:

1st. *The fetus is produced, and not merely developed,* since we perceive no trace of it before coition followed by impregnation.

(1) The works we shall mention treat more or less perfectly of the changes in the organism of the female and of those in the new being:—J. C. Aranzi, *De humano fœtu libellus,* Venice, 1751.—Fabrice of Aquapendente, *De formato fœtu,* Padua, 1604.—G. Harvey, *Exercitationes de generatione animalium,* London, 1651.—C. Drelincourt, *De conceptû,* Leyden, 1685.—M. R. Besler, *Admirandæ fabricæ humanæ mulicbris partium generationi inservientium et fœtus fidelis quinque tabulis, hactenus nunquam visis, delineatio,* Nuremberg, 1640.—Haller, *Historia nuperæ dissectionis feminæ gravidæ,* Gottingen, 1734.—G. Noortwyk, *Uteri humani gravidi anatome et historia,* Leyden, 1743.—D. Monro, *The dissection of a woman with child, and remarks on gravid utêri;* in the *Ed. phys. and liter. essays,* vol. i., art. 17.—A. Monro, *Additional observations on gravid uterus;* ibid., art. 18.—J. G. Rœderer, *Icones uteri humani observationibus illustratæ,* Gottingen, 1759.—C. N. Jenty, *Demonstratio uteri prægnantis mulieris cum fœtu ad partum matur.,* Nuremberg, 1761.—Azzoguidi, *Observationes ad uteri constructionem perfinentes,* Bologna, 1773.—G. Hunter, *Anatomia uteri gravidi tabulis illustrata,* Birmingham, 1774.—E. Sandifort, *De utero gravido;* in the *Obs. anat. pathol.,* vol. ii., Leyden, 1778.—J. Burns, *Anatomy of the human gravid uterus,* Glasgow, 1797.—Moreschi, *De utero gravido,* Milan, 1817.—Maygrier, *Nouvelles démonstrations d'accouchemens,* Paris, 1822.—Mad. Boivin, *Mémorial de l'art des accouchemens,* Paris, 1824.

2d. The most general condition necessary to produce it is the action of the normal seminal fluid of the male on the genital organs of the other sex, in a state of maturity, and when their vitality is exalted.

3d. The most important of the special conditions is the necessity of a certain relation, a certain resemblance, between the male and the female organism.(1)

The first problem to resolve is the mode in which the semen of the male produces conception. On this subject there are two opinions:

1st. Some admit that the semen arrives at the ovary through the uterus and the Fallopian tube; that it causes directly the changes which occur in this organ, and even that its substance unites more or less in the uterus with the product of the ovary, to give rise to the new organism.

2d. Others think that the semen does not act on the ovary directly, but only secondarily, by a change which it causes in the whole organism or in the genital organs, and does not contribute by its proper substance to form the new organism.

The principal facts in support of the first hypothesis are:

1st. The necessity of a channel for the semen, in order that the impregnation may occur, since it does not happen when the cavity of the female genital organs is interrupted.

2d. The semen found in the uterus and the Fallopian tubes in females who died during or shortly after coition.

3d. The necessity of copulation even to produce a new organism, for it is difficult to admit that impregnation may occur equally in any part of the body destitute of an epidermis, or at least covered by an epidermis as thin as that of the genital organs, as has been asserted.(2)

4th. The analogy of those animals in which the eggs are impregnated on leaving the body of the female by the semen of the male.

But these facts are not sufficient to demonstrate the exactness of the hypothesis they are adduced to support:

1st. In regard to the first argument, sterility may possibly depend on other causes, and besides it would follow only that the semen must necessarily act on a certain organ, as the uterus or vagina, in order that impregnation may occur.

2d. Perhaps the fluid found in the uterus and Fallopian tubes was not semen, but was secreted by the female genital organs, and this is often found in the cavity of these two organs.

3d. The third argument proves only that the semen must act on a certain organ.

4th. The fourth proves at most that the condition mentioned is rigorous in the animals to which it relates. Still it does not even de-

(1) Wolstein, *Ueber das Paaren und Verpaaren der Menschen und Thiere*, Altona, 1815.
(1) Treviranus, *Biologie*, vol. iii. p. 407.

monstrate this, as the ova of these animals are surrounded by a thick layer of mucus.

We may also adduce against this hypothesis and in the support of the second the following arguments:

1st. The experiments in which yellow bodies at least have been developed, although the Fallopian tubes had been carefully tied.(1

2d. In careful experiments on generation semen has seldom been found in the uterus, and the consequences of conception are not manifested till several days or weeks after coition.

3d. In most animals the genital organs are so arranged, that on account of their length and tortuousness in the females, the marked prominences on the neck of the uterus, and the shortness of the male organs, it seems almost impossible for the semen to arrive at the ovaries.

4th. The uniform sensation of pleasure and numerous general signs which attend impregnation.

Hence it follows that the influence of the male is confined to exalt the formative power in the female to the degree necessary to produce the new being. This increase is manifested, as we shall soon state, by the direct formation in the ovary of a new organ, a *temporary testicle*, which secretes a fluid possessing the power of spontaneous growth.

ARTICLE FIRST.

OF THE CHANGES IN THE GENITAL ORGANS PRODUDED BY COITION AND CONCEPTION.(2)

I. ORGANS OF COITION.

§ 2557. Coition usually changes the external genital organs very much; the hymen is generally more or less perfectly destroyed. Its remains give rise to the *carunculæ myrtiformes*, which term applies to three or four small eminences, most generally triangular, which are situated on the sides and posterior parts of the vagina. The existence of the hymen is not, however, a certain mark of physical virginity: first, because this membrane has frequently been found, not only in females who had several times had connection,(3) but also in others who had given birth to fetuses more or less advanced, and fetuses even

(1) J. Haighton, in the *Phil. trans.*, 1797.
(2) S. Pineau, *De virginitatis notis, graviditate et partu*, Leyden, 1654.
(3) Osiander (*loc. cit.*, p. 24) mentions several cases of it.

seven months old ;(1) and second, because it may have been destroyed from other causes, and even may not exist from a primitive deviation of formation.

The enlargement of the vagina and the disappearance of its corrugations are still less constant and sensible.

II. FORMATIVE ORGANS.(2)

A. OVARIES.

§ 2558. The internal organs of generation are modified not by coition, but only by eoneeption.

A speeial body, termed the *yellow* or *glandular body* (*corpus luteum*, s. *glandulosum*),(3) is developed in the ovary. It is a rounded, soft, very vaseular tissue, eomposed of several lobes; it projeets above the surface of the ovary, beeomes about as large as a eherry, and ineloses a eavity whieh opens externally. The number of the yellow bodies usually eorresponds to that of the new organisms whieh have been formed.

From experiments on animals, these bodies arise from the ehange of one and not probably of several of the vesieles of Graaf, whieh, from being a simple serous membrane, is ehanged into a glandular organ, that is, its organism beeomes more eomplex, and it aequires the faeulty of produeing a liquid different from the serum of the vesicles. As the yellow body differs in its strueture from all the other glands, the fluid it seeretes has also peculiar characters: it is the generating fluid, the semen of the female.

The influenee of the male semen is the usual and regular cause of this change, whieh however seems to oecur also from the effeet of other stimuli, perhaps of the imagination or unnatural indulgences. In faet several rare eases, where yellow bodies have been found in unmarried females and virgins, and always attended with the phenomena mentioned above, lead us to think that the formation of these bodies had been preeeded by the aet of coition, and by impregnation. However as they have been found in animals generally sterile, as mules, our opinion as eoneerns females is very probable; but we are not authorized by facts to think that the change of the vesicles of

(1) Tolberg, *De var. hym.*, p. 14.—We have in our cabinet the anatomical specimen, which is very remarkable.

(2) M. Malpighi, *De cornuum vegetatione, utero, viviparum ovis;* in the *Opp. omn.*, Leyden, 1687, vol. i. p. 211.—A. Bertrandi, *Observations sur les corps glanduleux, sur la matrice et sur l'ovaire dans l'état de grossesse;* in the *Miscell. Taur.*, vol. i. 1758.

(3) Brugnone, *De ovariis eorumque corpore luteo observationes anatomicæ;* in the *Mem. de Turin*, 1790.—Roose, *Ueber die gelben Körper und Eierstöche*, Brunswick, 1800.

Graaf into yellow bodies can be produced except by an unusual increase in the propensity to generation.(1)

Some have mentioned yellow bodies found in newly born or very young animals; but it is easy to reply to this objection that every yellow substance found in the ovary is not a yellow body. Nor is the argument drawn from the fact that the number of the yellow bodies does not always correspond to that of the offspring, conclusive. If the number of yellow bodies be fewer than that of the offspring produced by the female, this circumstance agrees with their signification, since one yellow body as well as one testicle may produce several new organisms. Farther one or more of these bodies also might disappear or several be blended together. In the case where they were more numerous than that of the offspring: 1st, it is necessary to mention exactly if these which were supernumerary did not arise from anterior conceptions; 2d, it would be possible, even in admitting that the animal has never conceived previously, that generation has not proceeded beyond the production of a yellow body, or that its production was lost. Besides we are very much disposed to consider as very uncertain, observations in the cases where it is pretended that the number of yellow bodies and that of the offspring differed, for the examination of more than two hundred women, and females of different mammalia in the state of pregnancy, has convinced me, that *the number of yellow bodies which from the absolute identity of all their characters may be considered as produced by the same generating act, always corresponds to that of the young*. Observers known for their correctness have come to the same conclusion,(2) while contrary assertions do not appear to be well supported.

The cavity of the yellow body is gradually obliterated; the body itself diminishes, collapses, and hardens. These changes do not happen exactly at the same period, and we have remarked generally in the human species or in animals, at least in respect to the size of the body, they are not very large during pregnancy, while after parturition they evidently increase more rapidly. This phenomenon is worthy of notice, as it teaches us that although the function of the yellow body and the ovary generally has passed at this period, vitality however continues to be more active in them on account of the great degree of vitality in the uterus. Farther the yellow body rarely disappears entirely, although it diminishes extremely.

Haller(3) and several others since his time have attributed the discovery of the yellow bodies to Volcher Coiter;(4) but it really belongs

(1) Joerg, *Von der Zeugung*, p. 151.

(2) Haller, *El phys.*, vol. viii. pt. ii. p. 29–38.—Hunter, *Anatomische Beschreibung des menschlichen schwangern Uterus*, Weimar, 1802, p. 20.

(3) *El phys.*, vol. viii. p. 38.

(4) *Obs. anat.*, 1573, p. 124. *Vesiculæ quædam continebant aquam limpidam, quædam luteum humorum.*

to Fallopius,(1) who mentioned these bodies twelve years before Coiter, and nearly in the same language.

Malpighi(2) and Graaf(3) discovered their uses.

§ 2559. According to Osiander(4) the vesicles of Graaf and the yellow bodies have no connection with generation, because the former have no openings. He asserts that after coition the parts which are changed into new organisms are developed on the surface of the ovary in the form of miliary vesicles, one of which is detached and falls into the uterus. He adds that we must consider these corpuscles as ova: 1st, because they never appear before impregnation; 2d, because they are always observed after coition followed by impregnation; 3d, because many are found in the cadavers of young females dying after a few pregnancies; 4th, because many are turgescent, others empty, and finally others resemble simple cicatrices; 5th, because they disappear entirely when the female is sterile.

These reasons do not seem satisfactory to us. The vesicles mentioned may be developed after copulation and disappear during life, although there were in fact no ova, since coition, when followed by conception, produces as great and to a certain extent even analogous changes in remote parts and in the whole organism.

Besides we have frequently found the ovaries of females, physically and morally virgins, covered with a very dense miliary eruption, and in them the vesicles were too numerous to admit Osiander's opinion in respect to them.

Finally we may alledge against this hypothesis the exact history of the changes in the vesicles of Graaf after impregnation.

The only argument adduced by Osiander to reject the use attributed to the vesicles of Graaf has no weight except against an unimportant opinion, that the vesicle itself is detached, and that the yellow body grows in its place; but this has no weight at all when, as seems to us more correct, we consider the yellow body a vesicle changed, which, according to all observations, is provided on the surface of the ovary with an opening communicating with its cavity, and through which the formative fluid may escape.

B. FALLOPIAN TUBES.

§ 2560. The only change produced by coition in the Fallopian tubes is this; soon after this act they are applied to the ovaries, so as to embrace a greater or less portion with their fimbriated extremity,

(1) *Obs. anat.*, Venice, 1561. *Vidi quidem in iisdem (ovariis) quasdam veluti vesicas aqua vel humore aqueo, alias luteo, alias vero limpido turgentes;* in the *Opp. omn.*, Venice, 1606, p. 106.
(2) *Loc. cit.*, p. 223.
(3) *Loc. cit.*, p. 331.
(4) *Handbuch der Entbindungskunst*, Gottingen, 1802, vol. i. p. 129–145.

and to receive the fluid poured out by the yellow body, which they then carry into the uterus.

Their approximation to the ovaries is favored by the portion of small intestine situated in the lower pelvis; for this portion tenses the ligaments of the ovaries and the broad ligaments of the uterus, thus fixes the glands in their position, and applies the tubes to their surface, so that they extend a little on the outside of them.(1)

c. UTERUS.

§ 2561. The structure of the uterus(2) undergoes remarkable changes in many respects, and the new organism is developed within it.

Even before we perceive any trace of the new being, we already find the uterus a little enlarged at its upper part, its substance is softer, looser, more lamellar, its component layers are more distinct, its vessels are dilated, its inner face is smooth but irregular, extremely vascular, and also covered with numerous very minute flocculæ, which cannot be seen except with a microscope, and finally it is covered with a pultaceous matter into which the vessels extend, and which passes on the neck of the organ, so as to close the cavity of the body. This substance resembles coagulated blood. It is thickest at its upper part, where it is connected with the uterus more intimately than in any other place. Below it is very thin and united to the organ more loosely, and even does not adhere to it at all.(3)

The vaginal orifice and the neck are also filled with a viscous, shining substance, similar to gelatine.

These changes increase uninterruptedly until the end of pregnancy, which generally continues ten lunar months.

The fibrous texture becomes more and more distinct: it cannot well be perceived(4) except during pregnancy or in analogous states of the uterus, when this organ also enlarges, as for instance, when abnormal formations are developed within it. It is then certain that if the fibres do not form during pregnancy they are at least developed and very much enlarged at that time.

(1) Autenrieth, *Ueber die eigentliche Lage der innern weiblichen Geschlechtstheile;* in Reil, *Archiv. für die Physiologie*, vol. vii. p. 294.

(2) Beside the works already mentioned in respect to the uterus, consult also: A. Vater, *De utero gravido*, Wittemberg, 1725.—Beyer, *Utrum in gravidis totus uterus æqualiter extendatur*, Paris, 1729.—P. A. Boehmer, *Situs uteri gravidi fœtusque, ac sedes in utero*, Halle, 1748.—B. S. Albinus, *Tabulæ uteri gravidi*, Leyden, 1748.—Id., *De utero gravido nonnulla;* in the *Annot. acad.*, l. ii. cap. v.—J. Weitbrecht, *De utero muliebri (gravido) observationes anatomicæ;* in *N. C. Petrop.*, vol. i. p. 337.

(3) *The case of a young woman who poisoned herself in the first month of her pregnancy, by Th. Ogle; to which is added an account of the appearances after death, by J. Hunter;* in the *London med. trans. for the improvement of med. and chir. knowledge*, vol. ii. p. 63.

(4) This remark had been made already by Vesalius (*De corp. hum. fab.*, book v. c. xv.), and by Santorini after him (*Observ. anat.*, c. x-i, § 13).

Hence why the uterus, although it enlarges and becomes much softer, is not only distended but enlarges considerably.

Some days after parturition occurs, when the term of pregnancy has been normal, the uterus weighs at least twenty-four ounces, as we have proved by examining twelve cadavers of females dying at this period; so that even then, although the organ had already collapsed, its weight was to that of the uterus in a virgin as 24 : 1.

Another question now presents itself, viz. do the parietes of the uterus, which, from the preceding remarks, are not only distended, but also become thicker, remain the same, or do they grow thinner? The latter perhaps is true, notwithstanding the increase in mass and weight, on account of the considerable extension of the uterus during pregnancy.

This problem has been resolved several different ways.(1)

Those who admit that the parietes of the uterus preserve the same thickness, or even become thicker, explain the contrary assertion by saying that the thickness of the uterus, considered generally, varies in the state of pregnancy,(2) and that an uterus, when filled with the product of conception, has not the same thickness in every part.(3) We may also say that sometimes the uterus, from a pathological state, is not properly developed, and is only distended, which perhaps is one of the causes which contribute to render parturition painful.

Our observations made upon sixteen uteri at all periods of gestation, lead us to think that very probably the parietes become a little but not much thicker at first, and that towards the end of pregnancy they gradually become much thinner.

In fact we have found the parietes of the uterus six lines thick, three weeks after conception; five, at the beginning of the third month; four, at the commencement of the fourth; at the end of this month, four in two cases: three at the upper part, and four at the lower in a third, and five in a fourth case; at five months, three lines thick in one case, two at the upper part, and four in the lower in another; at six and seven months, a little less than three; at eight months, from two to two and a half lines in one case, and in another, three lines at the upper part, and more than four at the lower: they have appeared to us a little thinner at nine months.

On the contrary the uterus when collapsed after parturition is generally an inch thick at the end of seven, eight, and nine months.

The veins and the arteries of this organ are extremely dilated, so that the venous trunks are as large as the axillary veins. These two orders of vessels become less tortuous as the uterus enlarges.

(1) Haller has collected most of the opinions on this subject (*El phys.*, vol. viii. p. 2. p. 58).
(2) For instance, F. A. Walter, *De polypis;* in the *Annot. Ac. Berol.*, 1786, p. 3.
(3) Hunter, *loc. cit.*, p. 21.

The dilated veins of the uterus have very improperly been termed *sinuses*.

The place where the blood-vessels are most developed is where the new organism unites directly with that of the mother, that is, at the insertion of the placenta.

§ 2562. The form of the uterus is also considerably changed. As the body only of the organ is developed during most of pregnancy, the disproportion between it and the neck always becomes greater, and even, as when the neck is finally distended, in the latter periods of pregnancy it shortens in proportion as it enlarges, the disproportion only becomes still more perceptible, so that the uterus is rather oval than pyriform, especially near parturition.

This organ also becomes considerably thicker from before backward in proportion to its breadth than it was before, although it still continues to be a little more broad than thick.

The orifice of the vagina begins to become round at the first month.

§ 2563. Great changes supervene also in the situation of the uterus.

During the first two months of pregnancy the uterus gradually descends a little in the pelvis, so that its orifice is more easily perceived with the finger introduced into the vagina; but at three months it begins to reascend, and also changes its direction, its base goes farther forward, and its orifice backward. These changes increase so much, as pregnancy advances, that it becomes more and more difficult to reach the os tincæ, and more so as the lower part of the anterior wall of the uterus is crowded from above downward, before it, by the lower part, the head of the child. In most cases, in proportion as the uterus is developed, its base rises, and becomes evident through the distended integuments of the abdomen.

The anterior face of the organ, especially in the latter months of pregnancy, is situated directly behind the anterior wall of the abdominal cavity. It pushes the small intestine upward, backward, and on the sides; at least this intestine very rarely descends between the uterus and the anterior wall of the abdomen,(1) and this case probably never happens at the end of gestation.

§ 2564. After parturition the uterus contracts, and in a few days its parietes are more than an inch thick.(2)

Its volume returns gradually, and even during the first few weeks, to the size it had before pregnancy; its vessels contract, and at the same time its loose and lamellar structure disappears. It however always remains larger and softer than in a female who has never borne children. It begins to diminish much and to become harder only at an advanced age.

(1) D. Monzo, in the *Edinb. Essays, an. ob.*, vol. i. p. 456. At the sixth month of pregnancy.

(2) Hunter, *loc. cit.*

The orifice of the vagina, which in the latter period of pregnancy had become a rounded opening, resumes its ancient form: but it is generally torn more or less deeply, whence it is uneven and corrugated. The lips, particularly the posterior, are thicker and longer. They are adapted to each other less exactly.

ARTICLE SECOND.

DEVELOPMENT OF THE NEW ORGANISM.(1)

§ 2565. The first origin of the new organism is very obscure. We do not know whether the fluid secreted in the yellow body directly assumes any form, so that the ovary furnishes a vesicle filled with liquid, which is the first trace of the *ovum* or of the *envelops* (*involucra*, s. *membranæ*) of the fetus: or if this change takes place only in the tube, perhaps even in the uterus.

The possibility of the development of the new organism in the ovary does not prove that the fluid of the vesicles is changed there in the normal state; we ought only to conclude that when this fluid does not arrive in the uterus it may assume in every other part the form of an ovum.

It is very doubtful(2) whether the ova, discovered in the Fallopian tubes,(3) of animals, were really what they were supposed to be, and more so because other observations render another mode of development probable, and particularly that the ovum takes its form in the uterus.(4)

But there is a rounded vesicle, composed of several membranes adapted to one another, and containing different fluids, constantly formed before the fetus. The fetus is developed within the ovum, which connects it with the organism of the mother. As the human ovum is generally ruptured at its lower part at the period of parturition, and the infant is delivered before it, it is termed the *secundines* (*secundæ*, s. *secundina*).

(1) Beside the works cited above, which treat also of the changes in the genital organs, consult: T. Kerkring, *Anthropogenia*, Amsterdam, 1670.—M. Schurig, *Embryologia*, Dresden, 1732.—F. G. Danz *Grundriss der Zergliederungskunde des ungebornen Kindes*, Frankfort, 1792–1793.—C. F. Burdach, *De primis momentis formationis fœtus*, Konigsberg, 1814.—O. C. Lucæ, *Grundriss der Entwicklungsgeschichte des menschlichen Körpers*, Marburg, 1819.—Beclard, *Embryologie, ou Essai anatomique sur le fœtus humain*, Paris, 1820.

(2) Hartmann, *Dubia de generatione viviparorum ex ovo*, Koningsberg, 1699, § 14.

(3) De Graaf, *De mulierum organis*, cap. xvi.—G. Cruikshank, in the *Phil. trans.*, 1797.

(4) J. C. Kuhlemann, *Observationes circa generationis negotium in ovibus factæ*, Gottingen, 1753.—Haller, *De quadrupedum utero, conceptu et fœtu*; in the *Opp. min.*, vol. ii. p. 32.

I. ENVELOPS OF THE FETUS.

§ 2566. The membranes of the ovum(1) are much larger and heavier the farther the fetus is from the period of its formation. Taken with the fluid they contain, they are at first much heavier than the fetus, and they even weigh more than it at the end of the third month, after being emptied, although the disproportion is then less, as may easily be conceived. At the end of the third month, that is, after about the first third of fetal existence, their weight is nearly equal. After this period an inverse relation exists, so that the mean weight of the membranes of the ovum is to that of the fetus as 1 : 8, since a well grown fetus weighs about eight pounds, and the weight of the secundines, including that of the cord, weighs rather more than one pound.

The first trace of the fetus is the substance which fills the uterus soon after coition, and which seems to be only coagulated blood.

This substance forms the most external membrane of the ovum, the *deciduous* membrane.

A. DECIDUOUS MEMBRANE.

§ 2567. The *deciduous* membrane, *épichorion*, Ch. (*M. decidua*, s. *caduca*, *tunica ovi exterior*, *membrana Hunteri*),(2) which surrounds

(1) Beside the works already mentioned, particularly those of Nortwyck, Sandifort, and Hunter, consult: A. Vater, *Mus. anat. propr.*, tab. viii. Wittemberg, 1701. —Ruysch, *Thes. anat., VI.* tab. i. and ii.—G. Vater, *Mola prægnans*, with a plate. —O. Borrich, *Abortus humanus examinatus;* in the *Act. Hafn.*, vol. ii. p. 49.—B. S. Albinus, *De vasis placentæ parvulorum embryonum et de involucro, quo edita eorum ova continentur;* in the *Annot. acad.*, lib. i-xvii.—Id., *Nonnulla de embryonibus humanis ovisque, quibus continentur*, ibid., xix.—P. A. Boehmer, *Instit. osteol.*, Halle, 1751, tab. i. f. 7, 8.—D. C. Burdach, *De læsione partium fœtus nutritioni inservientium abortus causa*, Leipsic, 1768.—E. Sandifort, *De ovo humano, absque ullo fœtus indicio, et placentæ in hydatides degeneratione;* in the *Obs. anat. path.*, book ii-iii. p. 76.—Id., *De ovo humano*, ibid., book iii-vi. p. 91.—Blumenbach, *Institutiones phys.*, 1787, tab. iv.—S. T. Sœmmerring, *Icones embryonum humanorum*, Frankfort, 1799.—Denman, *Practice of midwifery*, London, 1801, tab. vi-viii.—Wrisberg, *Obs. anal. obst. de structura ovi et secundinarum humanarum in partu naturali et perfecto collectæ*, Gottingen, 1782.—C. G. Krummacher, *Diss. sistens observationes quasd. anat. circa velamenta ovi humani*, Duisburg, 1790.—J. F. Lobstein, *Essai sur la nutrition du fœtus*, Strasburg, 1802.—Samuel, *De ovorum mammalium velamentis*, Wurzburg, 1816.—Dutrochet, *Recherches sur les enveloppes du fœtus;* in the *Mém. de la soc. méd. d'émul.*, vol. viii., 1817, p. 1-60.—G. Cuvier, in the *Mém. du Museum*, vol. iii.—Dutrochet, *Observ. sur la structure de l'œuf des mammifères et examen de la doctrine de Cuvier sur cette matière;* ibid., p. 760-767.—Dutrochet, *Mém. sur les enveloppes du fœtus;* in the *Journ. compl. du Dict. des sc. méd.*, vol. v. p. 241.—Velpeau, *Sur les membranes du fœtus;* in the *Archiv. gén. de méd.*, November and December, 1824.

(2) Haller, *Elem. phys.*, vol. viii. p. 183.—Osiander, *Handbuch der Entbindungskunde*, pt. i. p. 191.—F. J. Moreau, *Essai sur la disposition de la membrane caduque, sa structure et ses usages*, Paris, 1814.

the envelops of the ovum belonging to the fetus, is attached by its inner face to the chorion, and by its external face to the inner face of the uterus.

It is entirely different from the other membranes, is thicker, more opaque, but infinitely less solid. It has about the consistence of coagulated fibrine, which it also resembles in its yellowish color.

Its thickness is not the same in all parts of its extent. It is generally thicker in the region of the placenta, and smaller at the lower part, opposite the internal orifice of the uterus, than in any other point.

It always diminishes from the moment of its origin, so that finally it is scarcely half a line thick. Its external face is at first uneven and corrugated; but in time it becomes smoother, as is already its internal face. The connections which unite it to the uterus are much looser in the early periods than at the end of pregnancy.

It presents in a greater or less portion of its extent more or less evident perforations, which give it a reticulated or cribriform appearance.

It receives a great number of vessels, which are prolongations of those of the uterus, and which descend obliquely into it.

§ 2568. The deciduous membrane not only surrounds the ovum: it forms a double layer around it, and it is consequently arranged like the serous membranes.

In fact, beside the portion of this membrane which unites it by its external face to the internal face of the uterus, there is a second which is reflected on the preceding, and is contained within it.

This second layer is attached by its inner face to the chorion, and is loose on its external face, while the other fold is loose on its internal face, and adheres to the uterus by the external.

The first fold of the membrane is called the *external* or *true deciduous* membrane (*M. decidua externa*, s. *vera*): the other is termed the *internal* or *reflected deciduous* membrane (*M. decidua interna*, s. *reflexa*); it has also very improperly been termed the *fungous deciduous* membrane (*chorium fungosum*).

The arrangement of the deciduous membrane however differs from that of the serous membranes, because the external fold is not only reflected upon the chorion, but also on leaving this point, where it is inflected, it is extended on the latter, which it consequently envelops in every part.(1)

(1) Moreau (*loc. cit.*, p. 16) does not assent to this opinion. When the ovum is separated from the uterus it seems in fact enveloped in every part by the deciduous membrane: but according to him, as the flocculent tissue which covers the placenta at the third or fourth month of pregnancy does not exist in the first, and as from the fifth to the seventh month it is changed into a real cellular tissue, to form the uterine portion of the placenta, into which the vessels of the fetus open with the uterine veins, we must consider it a tissue of secondary formation, similar to the deciduous membrane, with which it is continuous, and not as a part or appendage of this membrane. F. T.

The reflected deciduous membrane particularly is thin and reticulated, and it is much thinner than the chorion. It likewise becomes much thinner as the ovum enlarges. It also approaches the external deciduous membrane, to which it is finally more or less adherent.

§ 2569. The external deciduous membrane never extends beyond the internal orifice of the uterus. On leaving this point the uterus or the neck is filled only with a gelatinous fluid.

According to some observers the external deciduous membrane extends to a certain extent in the tubes, especially on the side where the yellow body is formed,(1) and it is open at the place of the uterine orifices of the tubes, as also at its lower part, that which passes on the inner orifice of the uterus.(2) Perhaps these openings exist at first, but the membrane seems to change very soon into a perfectly closed sac, since the lower opening does not exist during the first month,(3) and the upper two are also effaced at the second.(4)

§ 2570. It is not very easy to explain how the reflected deciduous membrane is formed. Most probably the ovum, or the fluid from which it is produced, penetrates into the substance of the deciduous membrane, which is always very soft and very loose, but which presents these characters primitively, the spaces resulting from them afterwards close, and the ovum is then developed in the cavity of the membrane.(5)

This theory agrees with the observations from which it has been concluded that the external and internal deciduous membranes are primitively distinct, that the external appears first, on leaving the base of the uterus, as a membrane possessing longitudinal blood-vessels, and consequently composed apparently of bands which have the same direction, and that the internal is developed afterward, on leaving the inner face of the preceding, and possesses horizontal vessels: so that the ovum on arriving at the uterus falls into a cavity, the roof and parietes of which are formed by the external deciduous membrane, while the floor is constituted by the reflected deciduous membrane.(6)

(1) J. Hunter, in the *Trans. for the improv.*, vol. ii. p. 67.
(2) G. Hunter, *loc. cit.*, p. 77.
(3) J. Hunter, *loc. cit.*, p. 67.
(4) Lobstein, *Sur la nutrition du fœtus*, p. 4.
(5) Moreau asserts that when the ovule enters the uterus through the Fallopian tube, it only pushes before it the deciduous membrane, which is already a little organized before its arrival; that it is covered, as is every internal viscus, by the serous membrane of the sphlancnic cavity in which it is situated; that this keeps it in contact with that portion of the uterus to which it is attached; that it is reflected on it on leaving the place where the placenta is formed, and which is the only part not covered by it; that the three openings admitted by Hunter do not exist: in a word, that the deciduous membrane is arranged exactly like the serous membranes. This theory is more probable than the ancient, and has been developed by Velpeau, who supports it by the observation and dissection of a dozen human ova. F. T.
(6) Burns, *Observations on the formation and structure of the human ovum;* in the *Edinb. med. and surg. Journal*, vol. ii. p. 1-4.

At least it follows from these same observations that the ovum is not introduced into the substance of the deciduous membrane at the same period as when this membrane is developed on the inner face of the uterus,(1) since the phenomena mentioned by us have been observed in the cases where the ova are still contained in the tubes.(2)

§ 2571. Notwithstanding its early appearance, the deciduous membrane does not belong to the fetus, and is not indispensable for its development, since it also forms equally in the uterus in cases of extra-uterine fetation, and the fetus then is not the less developed, although destitute of it.(3)

B. MEMBRANES OF THE FETUS.

§ 2572. The ovum, on the contrary, includes other parts which are essentially connected with the formation of the fetus. These parts are the *chorion*, the *amnios*, the *umbilical vesicle*, and the *allantoid membrane*, which we proceed to describe, without regard to the order in which they form, nor the part they take in the special vitality of the fetus.

1. CHORION.

§ 2573. The *chorion* (*chorion*, s. *chorion pellucidum*, s. *M. vasculosa*, s. *extima*), the most external of the special membranes of the ovum, is thin, transparent, and villous on its two faces, particularly the external. The villosities of this latter are much longer than those of the internal and ramify.

The external villosities are masses of vessels, the trunks of which unite to form the umbilical vessels.

These vessels are at first single, but more or less prominent at intervals like varices, and are composed only of veins.(4)

Notwithstanding its thinness and transparency, the chorion is formed of two layers, an internal and an external, between which wind small vascular trunks communicating with the villosities, and which arise from them.(5)

(1) Hunter, *loc. cit.*, p. 81.
(2) Burns, *loc. cit.*, p. 3.
(3) Chaussier, in the *Bull. de la fac. de Paris*, 1814, no. 6, vol. iv., p. 137.
(4) Lobstein, *loc. cit.*, p. 65.
(5) This opinion, admitted by Hewson, Bojanus, and Dutrochet, is rejected by Velpeau. He thinks that the chorion is always formed by a single layer, and if it is considered to be formed by two, it is only because rather a thick membranous concretion forms between it and the placenta when this latter is developed, which may be separated into several layers. As the placenta is developed on the outside of the chorion, the same anatomist also states that it covers the fetal face of this organ, and is even reflected on the cord, with which it arrives at the umbilicus, where it blends with the skin of the fetus. F. T.

Its external face is united with the internal face of the deciduous membrane, and by the internal with the amnios.

Although there may be on its external face only a great development of vessels, we cannot, however, demonstrate the existence of these latter in its substance. In fact many observers have admitted them, and even very recently it has been adduced in favor of their existence that the deciduous membrane contains so many of them, because, they say, these last must penetrate into the chorion; and the vessels of the deciduous membrane seem to us to have with those of the chorion a relation similar to that between the vessels of the uterine portion and those of the fetal portion of the placenta, and in this hypothesis we can easily conceive of the great vascularity of the deciduous membrane.

The chorion has no lymphatic vessels or nerves.

§ 2574. Its form and connections vary much at different periods of the life of the fetus. It is proportionally much thicker at first than it is subsequently: it is thicker than even the anmios, but gradually becomes thinner.

At this period also its structure and thickness are uniform in every part.

Its external face is villous in every part, and these villosities are at first longer than they are afterward and in the second month are tortuous and proportionally longer than before.. But after the third month these villosities gradually disappear in most of its extent, usually from below upward, so that the outer face of the membrane is finally almost smooth, and the portion which surrounds the insertion of the umbilical cord is the only one where we still observe the villosities compactly arranged, and uniting to form the cord.

This place forms with the deciduous membrane a rounded mass, which in the full-grown fetus occupies about the third of the circumference of the ovum, and is termed the *placenta.*

The chorion, which forms its inner face, is much thicker there than in other parts.

At first this membrane is united to the deciduous membrane more loosely than it is subsequently; but it is gradually attached to it so intimately that they are separated with difficulty, particularly on the circumference of the placenta, where the union occurs by numerous filaments, remnants of vascular villosities, with which its whole surface is at first covered.

II. AMNIOS.

§ 2575. The *amnios* (*amnion*, s. *tunica ovi intima*) is a very thin and transparent membrane, which directly envelops the fetus. Its external face adheres but feebly to the chorion, except where it covers

the inner face of the placenta: the internal, on the contrary, is loose. These two faces are perfectly smooth, excepting always some very loose cellular tissue which covers the external.

Often and perhaps even always during the early periods of pregnancy, this membrane is more or less separated from the chorion, which is much more extensive, and between them is a fluid termed the *false waters of the amnios* (*liquor amnii spurius*). But this liquid disappears early, at the second month,(1) when the two membranes touch, although they are sometimes separated at the fourth and fifth months.(2)

The amnios is reflected on itself at the origin of the umbilical cord, covers the umbilical vessels, of which it forms the external envelope on the sheath, and extends to the anterior face of the abdomen, where it is continuous with the projecting portion of the skin of this region which forms the umbilicus.

As yet neither blood vessels nor nerves have been found in the amnion, although very probably the substance which serves to unite it with the chorion contains the passages through which the nutritious and secretory fluid penetrates to it.

§ 2576. This membrane contains a liquid termed the *waters of the amnios* (*liquor amnii*),(3) which varies in several respects at different periods of the life of the fetus.

In regard to its physical qualities it is limpid and more or less transparent in the early periods of pregnancy; but at the end it becomes turbid and more or less flocculent. It is also at first thinner and less viscous.

It has a strong odor, analogous to semen. Its taste is slightly saltish.

It contains a considerable number of globules.

Its specific gravity is a little less than that of water.

Its absolute and relative quantities vary at different periods of pregnancy. The nearer the fetus is to its period of formation, the more abundant proportionally the waters of the amnios.

(1) Hunter, p. 67.
(2) Lobstein, p. 23-24.
(3) Franck, *De liquore amnii*, Gottingen, 1764.—F. A. Kœnig, *De aquis ex utero gravidarum et parturientium profluentibus*, Halle, 1769.—J. P. Hettler, *De liquoris amnii naturâ ac indole*, Giessen, 1776.—H. Van den Bosch, *De naturâ et utilitate liquoris amnii*, Utrecht, 1792.—P. Scheel, *Diss. de liquoris amnii arteriæ asperæ fœtuum humanorum naturâ et usu, cui adjectus est appendix sistens generaliora quædam de liquore amnii*, Copenhagen, 1799.—Buniva and Vauquelin, *Expériences sur les eaux de l'amnios;* in the *Ann. de chimie*, vol. xxxiii., and *Mém. de la soc. méd. d'ém.*, vol. iii. p. 229.—F. F. Reuss and F. A. Emmert, *Chemische Untersuchung des Fruchtwassers aus dem zeitigen Ei und der käsigen Materie auf der Haut der neugebornen Kinder:* in Osiander, *Annalen*, Gottingen, 1801, vol. ii. p. 107.—G. Egeling, *De liquore amnii, nec non positiones medici argumenti*, Leyden, 1813.—G. F. Fuckel, *De liquoris amnii in fœtus corporis superficiem pressione*, Marburg, 1819.

About the middle of gestation their weight nearly equals that of the fetus.

From this period they gradually diminish, so that even when the fetus is delivered without breaking the membranes, they do not weigh more than a pound, and in common parturition not more than eight ounces.

Their absolute like their relative quantity increases at first, but afterwards diminishes. Thus, for instance, we find only thirty-six ounces from the third to the fourth month.

In regard to chemical composition it is to be regretted that the waters of the amnios in the female have not yet been analyzed, nor comparative experiments made, which however are not difficult, in animals at different periods of gestation. All those we possess were made on the waters received at the moment of parturition, that is, in the latter periods of pregnancy.

According to Scheel the waters of the amnios contain free oxygen; but the analyses of it made since(1) have not confirmed this assertion.(2) We find in it no traces of loose alkali.

The fluid portion is composed of a considerable quantity of water, a little albumen, a still smaller proportion of gelatine, of the hydrochlorates of ammonia and soda, and of phosphate of lime. Heat, alcohol, and acids do not change it, or but very slightly.

The flocculæ are very similar to the mucus of the mucous membranes.(3)

Some think that the waters of the amnios are formed by the fetus and others by the mother. The first represent it as an excretion, and the second as a nutritious substance.

Among the first some think it comes from the urine of the fetus, and others that it is exhaled by the skin.

Many(4) suppose that its composition is mixed, especially in the latter periods of pregnancy, that it is formed partly of the excretion of the fetus, partly also by a nutritious substance.

The most probable opinion is, that the waters of the amnios are secreted at least in great part by the vessels of the mother, although at the end of pregnancy they are furnished partly by the fetus. We have been led to this opinion because it seems infinitely probable that this liquid serves for the nutrition of the fetus. In fact:

1st. As it seems to contain more nutritious substance than during the first periods, because more coagulum is produced by heat and al-

(1) Lassaigne (*Sur l'existence d'un gaz respirable dans les eaux de l'amnios;* in the *Archiv. gén. de Méd.*, vol. ii. p. 308) has found in the amniotic fluid of the sow 4.130ths. of a gas similar to the atmospheric air, as it was composed of azote 98.3, and of oxygen 21.7. F. T.

(2) Van Doeveren, *Obs. acad.*, c. vii. p. 103.

(3) Emmert, *loc. cit.*, p. 116.

(4) Emmert, p. 121.

cohol,(1) we can explain this difference by admitting that the nutritious substance has been absorbed at first, and that when it is less abundant it has been replaced by another mode of nutrition.

2d. The waters of the amnios are probably absorbed by the skin; for after tying a ligature around the limbs of a fetus plunged into this liquid, the sub-cutaneous lymphatics soon swelled, while those of the limbs which were not tied were empty.(2) Secondly, fetuses have been born with the mouth closed, and with an umbilical cord entirely separated from the placenta, closed and rounded at its loose extremity.(3)

3d. The amniotic fluid also penetrates through the mouth, since it has been found in the stomach, esophagus, cavity of the tympanum, and trachea, where it has been easily recognized both by its physical properties,(4) as by the silky hairs of the child, and also the meconium.(5)

4th. Correct observations teach us that the fetus inspires and swallows, by which the waters of the amnios penetrate into the digestive and air passages.(6)

5th. Animals newly born have been nourished for several weeks by keeping them in the waters of the amnios.(7)

But besides these uses relative to nutrition, the waters of the amnios fulfill other functions which contribute directly or indirectly to preserve the fetus:

1st. They preserve it from all commotion and compression.

2d. They keep up the normal distention of the womb.

3d. They connect the ovum and the uterus most intimately.

4th. They moderate the pressure of the fetus on the uterus.

But they do not serve, as has been said, to prevent the obliteration of the openings and the cavities of the body:(8) first, because we not unfrequently find such anomalies; second, because the mucous membranes have no tendency to adhere, at least unless alterations in texture supervene in them. The observations of abnormal anuses, which continued open for many years, proves also that these secrete fluids enough to prevent the union of their surfaces.

The waters of the amnios are useful also in parturition, because they dilate the orifice of the uterus, and lubricate the external organs of generation.

(1) Osiander, *Annalen*, vol. i. pt. i. p. 190–200.—Lobstein, *loc. cit.*, p. 103. We have always observed this in the fetuses of the ewe.
(2) Brugmans, in Van den Bosch, *loc. cit.*, p. 466, 467.
(3) Ibid.
(4) Winslow, Herholdt, Rafn, Abildgaard, Scheel; in Scheel, *loc. cit.*, p. 12.
(5) Osiander, *Handbuch der Entbindungskunde*, vol. i. p. 237.
(6) Winslow, in Scheel, *loc. cit.*, p. 12.—Beclard, in the *Bull. de la fac. de Paris*, 1813, no. 6–8.
(7) Weydlich, in Pohl, *Embryochemia*, Erlangen, 1805, § 12.
(8) Lucæ, in Fuckel, p. 10.

III. PLACENTA AND UMBILICAL CORD.

A. PLACENTA.

§ 2577. The *placenta*(1) is generally a rounded, oblong, soft, but solid mass, particularly at its circumference, and is composed of the chorion and the deciduous membrane. It is the most vascular part of the ovum, that by which it is attached most intimately to the uterus.

This body is generally eight inches long in its greatest diameter, six in the smallest, and one thick; but it gradually becomes thinner towards the circumference. Its thickest portion is where the umbilical cord is detached from it. It is generally inserted, especially in the first pregnancy, at the upper and posterior part of the uterus, a little to the right. None of the mechanical explanations of this phenomenon are satisfactory.(2)

The placenta is composed of a considerable number of lobes (*cotyledones*), which vary in size, and are rounded and irregular in form; they are particularly apparent on its outer or uterine face, and render it very uneven.

About the period when the fetus is full-grown, it is covered at its outer face by a layer very similar to the deciduous membrane, which extends not merely from one lobe to another, but penetrates between them and unites very intimately with the vessels of the placenta. These last communicate with those of the uterus. Between them and the placenta are very large veins. We remark particularly on the circumference of the placenta a circular vein, into which several veins of the deciduous membrane open.

Although this layer is similar in structure to the deciduous membrane, it seems however to form afterward, since the portion of this latter which corresponds to the placenta disappears soon after its union with the uterus, and the layer in question exists only during the latter half of pregnancy.(3)

The inner face of the placenta is smooth and formed by the chorion, which is thicker there than in any other part, and the amnios covers also its inner face.

We remark in it the largest of the branches and trunks of the three umbilical vessels which unite the body of the fetus with the membranes of the ovum.

The placenta grows constantly and absolutely after it is first formed; but it diminishes in proportion to the fetus and the other parts

(1) G. Munniks van Cleef, *De usu placentæ humanæ comparatione ejusdem cum animalium placentis illustrato*, Utrecht, 1819.

(2) B. F. Osiander, *De causâ insertionis placentæ in uteri orificium ex novis circa generationem humanam observationibus et hypothesibus declaratâ*, Gottingen, 1792.

(3) Wrisberg, *Descript. ovi et secund.*, § 183. Lobstein, *loc. cit.*, p. 58.

of the ovum, since the vessels of the chorion are mostly and gradually obliterated. Even a part of those of the placenta gradually close, and then appear so many cords filled here and there with phosphate of lime, particularly towards the upper face of the organ. This deposit occurs also out of the vessels. It is a sign of maturity, of old age, of the mortification of placenta, and it is therefore observed only when the latter is about to be detached.

The maturity of the placenta is indicated by its receiving fewer vessels; it becomes dryer, and even diminishes in its mass and size,(1) although these changes are much less evident in the female than in the females of animals.(2) We must then consider them as a commencement of separation between the organism of the child and that of the mother, as a prelude to parturition.

E. UMBILICAL CORD.

§ 2578. The *umbilical cord* (*funiculus umbilicalis*) is composed at least of the following parts during all of fetal existence.

1st. The umbilical vein and two arteries.

2d. A soft, semi-fluid, and gelatinous substance, which surrounds these vessels, and is termed the *gelatine of Wharton* (*gelatina Whartoniana*).

3d. The *urachus*.

4th. The *umbilical sheath* (*vagina umbilicalis*), which surrounds all these parts, and which proceeds from the amnios.

It also contains during the early periods, and particularly until the third month:

5th. A portion of the intestinal canal, which is much larger the younger the fetus is.

6th. The whole or a part of the umbilical vesicle.

7th. The omphalo-mesenteric vessels.

Hence why it is then much larger than it is subsequently.

At first until the second month, sometimes even later than this, but then an anomaly exists, the umbilical vesicles are straight. They gradually become more or less tortuous, and the cord also assumes this appearance, the more so as its caliber also diminishes. It is curious that these inflexions generally take place in the same direction, from left to right, which occurs nine times to one, judging from our observations.

The gelatine of Wharton varies in quantity. Hence the difference between *fat* and *lean* cords.

(1) Lobstein, *loc. cit.*, p. 141, 142.
(2) Joerg, *Ueber die Zeugung*, p. 220.

We may inject this gelatinous substance(1) with mercury by compressing it a long time; but we cannot conclude certainly from this that it receives special vessels for transmitting a fluid from the placenta into the body of the fetus. We can at most conclude from this experiment that the gelatine of Wharton is composed of tunnels adapted one to another, formed by cellular tissue, and containing a substance in motion which probably serves to nourish the fetus.(2) Although different ancient and modern anatomists assert they have discovered some lymphatic vessels in the umbilical cord,(3) neither Lobstein nor myself(4) have perceived them, notwithstanding all our researches on this subject.

The umbilical sheath envelops the parts which form the cord, but not tightly. It differs more from the skin of the fetus the older the fetus is.

We have not been able to satisfy ourselves of the existence of nerves in the umbilical cord,(5) and we therefore do not admit them.(6)

§ 2579. The umbilical cord does not generally arise from the centre of the placenta, but is inserted a greater or less distance from its edge. It is attached to the anterior face of the abdomen, as much lower, the younger the fetus is, and on leaving this part its constituent portions separate.

It varies in size and length at different periods of fetal existence. At first and until the end of the first month it does not exist, and the fetus rests directly on the amnios.

When it once begins to appear, it extends continually until the fetus is matured, so that it is generally about two feet in length at this time, and hence nearly as long as the full-grown fetus.

We must however remark that these two periods are generally separated by a third, during which the umbilical cord is proportionally longer, and exceeds more or less that of the fetus; this occurs at least from the end of the second to the end of the sixth month.

At the end of pregnancy, however, the cord is from one to two feet long.

§ 2580. The placenta and the umbilical cord establish the communication between the child and the mother. The first is essentially composed of two different parts, the *fetal* and the *uterine* portion.

(1) Uttini, *Sur les vaisseaux absorbans du placenta;* in the *Mem. dell' inst. nazional.*, vol. i.

(2) Lobstein, *loc. cit.*, p. 38.

(3) Michaelis, *Observationes circa placentæ ac funiculi umbilicalis vasa absorbentia*, Gottingen, 1790.

(4) *Loc. cit.*, p. 84.

(5) Chaussier and Ribes assert that they have followed the filaments of the ganglionnary nerves of the fetus along the umbilical vessels into the placenta. (Chaussier, *Expériences nouvelles sur le digestion, et remarques á ce sujet;* in the *Journ. univ. des sc. méd.*, vol. i. p. 233.) F. T.

(6) E. F. Durr, *Diss. sistens funiculum umbilicalem nervis carere*, Tubingen, 1815.—L. S. Rieck, *Utrum funiculus umbilicalis nervis polleat, aut careat*, Tubingen, 1816.

The *fetal* portion is formed by ramifications of the umbilical vessels and by the chorion; the *uterine* by the prolongations of the uterine vessels and by the deciduous membrane. These two portions are united much more intimately the older the fetus is; but their respective vessels always remain separate, so that the arteries and veins of the uterine portion communicate directly, as do those of the fetal placenta. Hence why injections of the uterine vessels, even when most successful, fill only the uterine placenta, while those through the umbilical vessels fill only the fetal portion. Hence also when we inject the placenta detached from the body, or when it is not separated from the body of the living infant, so that the blood circulates uninterruptedly within it, there is no dribbling of blood from its loose surface. Hence the pulses of the mother and the umbilical cord are not isochronous.

This explains why children born without the rupture of their envelops can live a greater or less length of time, the circulation continuing perfectly,(1) and probably only the change of temperature obliges us to open all the envelops, although Wrisberg has prolonged the experiment for nine minutes, and Osiander for a quarter of an hour.

The same fact explains why the cord, which remains for a long time in communication with the mother, after being separated from the body of the fetus, presents only a slight running, produced by the small quantity of blood contained in the fetal placenta.

Finally why fetuses can survive not only several hours when their mother perishes from hemorrhage, but can also preserve more or less the quantity of blood they generally possess.

§ 2581. The internal or fetal placenta is composed only of numberless ramifications of the umbilical arteries and vein, surrounded by a vaginal prolongation of the chorion.

The arteries and the veins always proceed together and are very much curved, like the trunks; their final ramifications even accompany each other constantly, so that we find a small artery and vein inclosed in the same vaginal prolongaion of the chorion.

This arrangement however occurs only in the latter periods of pregnancy; for during the early stages, the vessels of the fetal placenta are single and only venous, like those of the chorion in general.

Besides these vessels, we find in the placenta white tendinous filaments which arise from the chorion, enter with it between the vascular trunks, and seem to be only obliterated vessels, which are often half open and receive injections.

If we except a considerable and oblique anastomosis between the two umbilical arteries at the base of the placenta, their subordinate branches do not communicate from one lobe to another within this body. There is no other anastomosis between the branches of the

(1) In the experiments of Rœderer, Wrisberg, and Osiander (Rœderer, *De vi imaginationis in fœtum negandâ*, Gottingen, 1756.—Wrisberg, *Obs. de struct. ovi*; in the *Comment.*, vol. i. p. 618.—Osiander, *Annalen*, vol. i. pt. i. p. 27-28), which we have repeated with the same results on dogs, cats, and rabbits.

umbilical vein. On the contrary the arteries and veins are continuous by proportionally very large anastomoses.

This portion of the placenta is proportionally of a very loose tissue; the solidity of the whole mass depends on that of the next portion.

The placenta has no lymphatic vessels; and we cannot strictly demonstrate in it the existence of nervous filaments.

§ 2582. The uterine or external portion of the placenta is much firmer than the internal, and formed by the membrane similar to the deciduous membrane mentioned by us above.

This membrane covers its outer face, and gives it a warty appearance; but at the same time it sends internally numerous irregular prolongations, which penetrate between the most minute ramifications of the umbilical vessels, with which they form alternate elevations and depressions.

The uterine placenta, like the whole deciduous membrane which corresponds to it, is formed by the uterus, and its vessels are prolongations of the uterine vessels.

The arteries are very tortuous, and the diameter of the largest is nearly a line. The veins, which are less tortuous, but which go obliquely to the placenta, are infinitely broader. Numerous ramifications of veins arise from the deciduous membrane, which, after uniting in trunks, are distributed principally on the edge of the placenta.

The arteries and veins communicate in the uterine placenta, not by anastomoses, but by large cellules which may be completely filled, either through the venous or arterial trunks, and in which the injection is always effused before passing from the arteries into the veins.

These cellules should be considered as the larger openings of the vessels, since they have no special membranes, and form also large islands.

§ 2583. Notwithstanding the separation of the two circulations in the placenta, there is, however, between its two constituent portions and their vessels a relation of mutual action, which may be compared to that existing between the air and the blood in the lungs, or between the food and the chyliferous vessels in the intestinal canal.

§ 2584. The uterine placenta is only a transient production, of which the uterus is in great part disencumbered when the fetal placenta is expelled, although a portion of the deciduous membrane is not perfectly detached from the inner face of the organ until several days after delivery.

From this intimate connection between the uterine placenta and the uterus, although the section of the cord occasions only a slight and momentary flow of blood, as we have said above, there is, on the contrary, a greater or less hemorrhage from the rupture of its vessels when this portion is detached, which is soon stopped by the contraction of the uterus.

IV. UMBILICAL VESICLE AND ALLANTOID MEMBRANE.

§ 2585. Beside the membranes hitherto mentioned, the existence of which is certain, there are two not so generally admitted, but which are similar in form and situation, but differ from the two preceding in these two respects. They are the *umbilical vesicle* and the *allantoid* membrane. These two membranes do not form superimposed sacs and envelops of the fetus, but are situated between the chorion and the amnios. They do not continue as long as the other two membranes, since they disappear, or at least become inactive, at the third month of pregnancy. They however cannot be confounded with each other, nor can we suppose, with Lobstein, for instance,(1) that the umbilical vesicle of man is the allantoid membrane of animals. They are two entirely different organs, which coexist in most vertebrated animals, and apparently in man also.

A. UMBILICAL VESICLE.

§ 2586. The *umbilical vesicle* (*V. umbilicalis*, s. *saccus vitellarius*, s. *vesica vitellaria*, s. *intestinalis*, s. *processus infundibuliformis*, s. *hydatis funiculi*) is constant. Although Osiander has asserted that it should be considered as a pathological phenomenon, occurring only in monstrosities,(2) it really exists in every ovum during the early months of pregnancy.

The umbilical vesicle of man corresponds neither to the allantoid membrane of the mammalia(3) nor of birds: for the arguments drawn from its constancy, transparency, the clear and limpid fluid which fills it, its situation between the other membranes of the ovum, and the existence of vessels on its surface, adduced in favor of this comparison, are so many circumstances which demonstrate still better its analogy with the umbilical vesicle of the mammalia, and the vitelline sac of birds.

The nature of its vessels and its connections with the intestinal canal also support this analogy. Besides as the allantoid membrane is independent of it in the mammalia and in birds, and probably also in man, Lobstein's opinion cannot be admitted.

§ 2587. This vesicle is as much larger proportionally as the fetus is younger, and it at first probably exceeds it in size; at least Lobstein has figured a case of this kind,(4) and we have one almost similar before us.

(1) *Loc. cit.*, p. 44.
(2) *Salzburg med. chir. Zeitung*, 1814.
(3) Lobstein, *loc. cit.*, § 41-45.
(4) *Loc. cit.*, tab. i.

The umbilical vesicle figured by Lobstein is the largest known. We may judge from it that the organ is at first about six lines in diameter.

The largest umbilical vesicles before us are one half or more smaller: this agrees with the dimensions given by most authors.

§ 2588. This organ is at first situated directly against the anterior face of the fetus;(1) but it removes from it after the end of the first month, and is then situated on the outside of the umbilical sheath.

§ 2589. We know nothing certain in regard to the period when the umbilical vesicle appears. Judging from analogy with birds, as it corresponds to the vitelline sac, we might conclude that it arises before all other parts of the ovum, and on this account it has even been asserted that the *false germs* are umbilical vesicles, and not sacs formed by the chorion and amnios, as is generally supposed.(2) Although the received opinion be not perhaps applicable to all cases, we however shall continue to follow it until the contrary is proved by positive facts.

According to Hunter,(3) the umbilical vesicle sometimes continues to the end of pregnancy; but it is not larger at this period than in an ovum of two or three months, and is from half an inch to an inch and a half distant from the insertion of the umbilical cord in the placenta. We regard this fact as very rare, having found it only twice in a great number of deliveries.

§ 2590. The umbilical vesicle is formed by rather a thick granular membrane, which does not tear when forcibly distended with water.(4) It gradually collapses, is covered with wrinkles, and becomes opaque. The omphalo-mesenteric vessels are distributed in it.

It contains a whitish fluid, which gradually diminishes, becomes thick, and finally hardens.

§ 2591. We have treated of its connections with the fetus at some length in the history of the development of the intestinal canal, and we have attempted to demonstrate that very probably it communicates with the ileon by the omphalo-mesenteric vessels and by a canal.

§ 2592. Its constancy, its great size in the commencement, and its probable existence before other parts, prove that it takes a very important part in the development of the fetus.

Judging from what occurs in birds, its contents pass into the body of the fetus, and serve for nourishment, like yolk to the chicken. It however disappears sooner than the vitelline sac.

§ 2593. Opinions are still divided on the question whether there is, as in all the other mammalia, an *allantoid membrane* (*allantois*, s.

(1) Lobstein, *loc. cit.*, p. 46.
(2) Oken, *Beyträge*, pt. ii. p. 83.
(3) *Anatomie des schwangern Uterus*, p. 68.
(4) Lobstein, *loc. cit.*, p. 43.

membrana media,)(1) which communicates with the bladder through the urachus.

Needham,(2) Hale,(3) Bidloo,(4) Hoboken,(5) de Graaf,(6) Littre,(7) Rouhault,(8) Neufville,(9) Haller,(10) Emmert,(11) Joerg,(12) Dutrochet,(13) and Cuvier,(14) admit it. Paré,(15) Harvey,(16) Ruysch,(17) Heister,(18) Troortwyk,(19) Neu,(20) Albinus,(21) A. Monro,(22) Danz,(23) and Hunter,(24) deny it. Although some of the numerous facts adduced to support it are false, and others but slightly conclusive, we however agree with the first of these two opinions, because we have found in a human fetus about four weeks old, between the chorion and the amnios, and independent of the umbilical vesicle, a larger pouch, with thin parietes, collapsed, and containing a limpid fluid.(25) We have seen this since.

Its existence may be supported:

1st. By the cases where we have found in the other membranes a pouch different from the umbilical vesicle. In fact some observations of this kind are very suspicious; but we have several times been satisfied of the existence of a delicate layer, differing from the rest of the ovum, which first forms a close vesicle until about the end of the second month of pregnancy, and which afterward appears as a thin lamina.

2d. By the space between the amnios and the chorion. This space is greater in the early periods than afterward, and is filled by a fluid

(1) R. Hale, *The human allantoid discovered;* in the *Phil. trans.*, p. 270,—Sellius, *De allantoide*, Kiel, 1729.—C. de Neufville, *De allantoide humanâ*, Leyden, 1736.—Haller, *De allantoide*, 1739.—J. G. Betschler, *Diss. num a fœtu urina secernatur et secreta excernatur*, Berlin, 1820.
(2) *De formato fœtu, c.* iii.
(3) *Loc. cit.*
(4) *Tab. anat.*, 58, lit. E.
(5) *Anat. secund. hum. rep.*, p. 428.
(6) *De mulier. org.*, cap. xv.; *Opp. omn.*, p. 283.
(7) *Mém. de Paris*, 1701, p. 115.
(8) *Osservaz. anat. fis.*, Turin, 1724, p. 21.
(9) *Loc. cit.*
(10) *Loc. cit.*
(11) *Nachtrag zu den beiden Abhandlungen über das Nabelblaschen;* in the *Archiv. für die Physiologie*, vol. x. p. 373.
(12) *Die Zeugung*, p. 288. Joerg however draws his conclusions solely from the space often existing between the chorion and the amnios.
(13) *Loc. cit.*
(14) *Mém. de Mus.*, vol. iii.
(15) *Anat. chir.*, l. ii. c. xxxv.
(16) *Exerc. de gener. c. de memb. et humor.*
(17) *Thesaur.* 3, no. 57; *th.* 9, no. 21.
(18) *Eph. nat. curios. cent.* II., obs. 190.
(19) *De utero gravido;* p. iii., *De allantoide.*
(20) *De diff. fœt. et adulti*, p. 105.
(21) *Annot. acad.*, l. i. c. xix. p. 75.
(22) *Essays of a soc. of Edinb.*, vol. ii.
(23) *Loc. cit.*, p. i. § 12.
(24) *Anatomie des menschlichen schwangern Uterus*, p. 84.
(25) *Deutsches Archiv. für die Physiologie*, vol. iii. tab. i. fig. 2.

which is sometimes very abundant at parturition, and which forms what is termed the *false waters*.

3d. By the analogy with other animals.

This vesicle has always very thin parietes, which are more delicate than those of the other membranes.

It is not certain that it communicates at any period with the urachus. Dutrochet admits this communication, but has never observed it. It however probably exists, at least in the early periods of gestation, either from analogy, or because the urachus makes part of the umbilical cord, or finally from the possibility of following it there more or less to the placenta,(1) of introducing into it a liquid,(2) and even of demonstrating within it an immediate connection between this body and the allantoid membrane.(3) We have been able more or less easily to follow the urachus in almost its whole length at every period of pregnancy, and even to fill it partially with mercury: but we have never been able to prove that it communicated either with the space between the two proper membranes, or with the allantoid membrane.

We do not know certainly how long the allantoid membrane exists. We have seldom been able to trace it evidently in the latter months of pregnancy.

§ 2594. The allantoid membrane is generally considered as the reservoir of the urine, which is carried to it by the urachus from the bladder.

This is the opinion of most physiologists and physicians.

Joerg thinks even that the allantoid membrane itself secretes urine,(4) which is not very probable, since the kidneys exist, and are more developed than at subsequent periods of life.

Harvey,(5) Lobstein,(6) and Oken,(7) have advanced another opinion.

Harvey maintains that the liquid of the allantoid membrane is not urine, but a nutritious fluid:

1st. Because it exists in the ova where there is no fetus.(8)

2d. Because it is abundant when the organ is formed.(9)

3d. Because the allantoid membrane is at first proportionally and even absolutely much larger than subsequently,(10) while it is admitted that the secretion of the urine is in a direct ratio with the advanced age of the fetus.

(1) Albinus, in Neufville, p. 42, 43.—Hunter, *loc. cit.*, p. 45.—Cruikshank, *ibid.*
(2) Noreen and Rœderer.—A. Monro, in the *Edinb. phys. essays and obs.*, vol. i. p. 485.—Ridley, *Obs. med. pr.*, London, 1703.
(3) Albinus, in Neufville, p. 43. But this undoubtedly refers to the umbilical vesicle.
(4) *Zeugung*, p. 298.
(5) *De gener. anim.*, Amst., 1662, p. 364.
(6) *Loc. cit.*, p. 53.
(7) *Beyträge*, pt. i. p. 29.
(8) Harvey.
(9) *Id.*
(10) Lobstein, p. 54.

4th. Because we cannot conceive why the urinary secretion should be the most important function in the fetus.(1)

5th. Because the allantoid membrane is deficient in some mammalia, and it is very improbable that the fetuses of some animals should secrete urine and others not.(2)

6th. Because it is very difficult in the nearly perfect fetus of the adult to pass air from the bladder into the allantoid membrane.(3)

7th. Because the fluid would not be excretory, since a considerable number of umbilical veins (absorbents) are distributed in the enveloping membrane.(4)

8th. Because the fluid differs from the urine.(5)

But all these arguments prove nothing against the old opinion, or in favor of that of the writers who adduce them.

1st. The existence of the allantoid membrane and its fluid without a fetus proves nothing, and that considered as such may be something else, or the fetus may not be deficient.

2d and 3d. The size of the allantoid membrane and the quantity of its fluid during the early period of gestation, are explained very well by the more rapid progress of all the formations at this period, and because very probably the other excretions do not take place then, or at least but slightly.

4th. The size of the allantoid membrane does not prove that the urinary secretion is the most essential of all the functions, but only that it replaces in great part all the other excretory systems, from the simple reason that the products of the action of these latter had been in contact with the fetus during the whole of pregnancy.

5th. This fact is entirely incorrect, for the allantoid membrane is very constant. Farther its absence might possibly be compensated for in some way.

6th. In this case the same difficulty exists in passing air from the allantoid membrane into the bladder,(6) while it is very easy during the early periods of gestation, as we have more than once proved. It follows then at most from this fact, that the quantity of urine secreted gradually diminishes, and collects in the bladder.

7th. This objection rests upon confounding the allantoid membrane with the chorion. The vessels do not belong to it, but to this latter; at least they do not absorb within it, but in the cavity of the uterus.

8th. It does not follow, for several reasons, from the fact reported, that the liquid was not urine.

We cannot consider the allantoid membrane as the formative membrane of the urinary and genital apparatus, or of the bladder,(7) for it

(1) Id., *ibid.*
(2) Id., *ibid.*
(3) Oken, p. 58.
(4) Harvey.
(5) Oken, p. 39
(6) Ibid., p. 30.
(7) Joerg, p. 298.

birds it arises very evidently from the urinary system, and does not exist in the ova of the batracia.

The bladder is not formed by the urachus;(1) but the canal corresponding to the bladder and urachus, which was at first uniformly narrow, enlarges at its lower part, is completely developed and becomes the bladder, while the upper part, which is not developed in the same manner, remains the urachus.

II. ORIGIN OF THE OVUM, AND THE ORDER IN WHICH ITS PARTS FORM.

§ 2595. It is extremely difficult to determine the period at which the ovum first appears. Although the duration of pregnancy is ascertained with certainty, it does not necessarily follow that the new organism always begins to form at the same period, for the development of the embryos of birds proves that although the ova are all matured at the same period, there is, however, a great difference between embryos of the same brood in the development of different organs, or of the whole body.

From the eighth day after coition a tendency to form the deciduous membrane, and also the fetal portion of the ovum,(2) has been observed.

From the rapidity with which the transitory or permanent parts of the body form successively in the superior animals, and from the proportionally very small number of perfect observations on the development of the ovum in particular, it is extremely difficult to determine if the different parts of this latter, described in the preceding article, form at the same time or at different periods, and also the order of their appearance, and their part in the formation and development of the fetus.

Very probably, however, the deciduous membrane begins to form at the same time as the ovum, or the fetal portion of it, since we observe the changes in the uterus, connected with its appearance, very early, even before the latter is seen there.

Hitherto physiologists have generally considered the chorion and the amnios as the most essential parts of the ovum, those which arise first; and even now the external of the two membranes to which the least advanced ova can be reduced is considered the chorion, and the internal as the amnios.

Analogy with the development of animals inferior to the mammalia, however, renders it very probable that the umbilical vesicle is developed the first, and that the other membranes form after it, since in the animals mentioned, the vitelline sac, which corresponds to the umbilical vesicle, appears long before all other parts of the ovum, which precede only the body of the fetus.

(1) Ibid., p. 290.
(2) Home, *Phil. trans.*, 1817, pt. ii. p. 256-261.

III. FETUS.

§ 2596. It is very difficult to determine precisely the period when the human fetus(1) forms. This ought not to surprise, for this is still more uncertain in the history of the oviparous animals even, notwithstanding the greater facilities they present to the observer, and the numberless observations upon them. It however is certain that a greater or less length of time elapses after coition, followed by impregnation, before the ovum becomes visible.

We may admit generally that it appears in the second week after coition, and there are very probably greater or less differences in this respect. Haller's(2) opinion, however, that the fetus does not become visible till the end of the third week does not seem to be entirely correct, since it does not agree, among others, with Home's observation mentioned in the preceding article.

I. MODE OF ORIGIN.

§ 2597. The problem of the mode of origin of the fetus is still more difficult, and all that has been said on this subject is reduced almost to hypothesis, instead of observations and facts.

It is certain, however, that the fetus is united to its membranes from the first.

The contrary opinion that it arises in the waters of the amnios, without any adhesion, cannot be sustained. It is supported by the following arguments :(3)

(1) Beside the works already cited in the course of this book, consult also: 1st. On the form and structure of the fetus:—Cassebohm, *De differentiâ fœtûs et adulti anatomicâ*, Halle, 1739.—C. J. Treu, *De differentiis quibusdam inter hominem natum et nascendum intercedentibus*, Nuremberg, 1736.—Hebenstreit, *Programma de anatome hominis recens nati*, Leipsic, 1739.—Treu, *Descriptio et delineatio embryonum humanorum ;* in the *Comm. Nor.*, 1739.—J. G. Rœderer, *De fœtu perfecto*, Gottingen, 1750.—J. A. Langguth, *De anatomiæ embryonis trium cum dimidio mensium*, Wittemberg, 1751.—J. G. Rœderer, *De fœtu observationes*, Gottingen, 1758.—H. A. Wrisberg, *Descriptio anatomiæ embryonis observationibus illustrata*, Gottingen, 1764.—A. B. Koelpin, *De fœtûs et adulti differentiis*, Gripswald, 1764.—J. F. Dietz, *Differentia fœtûs ab adulto*, Giessen, 1770.—A. and F. Rosslein, *De differentiis inter fœtum et adultum*, Strasburg, 1783.—Autenrieth, *Supplementa ad historiam embryonis humani*, Tubingen, 1797.—S. T. Sœmmerring, *Icones embryonum*, Frankfort, 1799.—2d. On its mode of existence:—Rose, *De naturâ embryonis humani*, Leipsic, 1774.—J. Van Solingen, *De vitâ fœtûs propriâ*, Utrecht, 1782.—A. Brendel, *De nutritione fœtûs in utero materno*, Wittemberg, 1704.—Treu, *De chylosi fœtûs*, Altdorf, 1715.—Bernhardi, *De nutritione fœtûs in utero*, Halle, 1732.—J. de Diest, *An sui sanguinis solus opifex fœtus*, Paris, 1725.—A. Nann, *Eversa vasorum rubrorum uteri anastomosis et communicatio cum placenta*, Erford, 1751.—R. Forsten, *Quæstiones medicæ*, Leyden, 1774.—Schaffer, *De commercio fœtûs cum matre per nervos*, Erlangen, 1775.—Richard, *De modo nutritionis fœtûs*, Erford, 1783.—Stoy, *De nexu inter matrem et fœtum*, Halle, 1786.

(2) *El. phys.*, vol. viii. p. 61.

(3) C. F. Burdach, *De primis momentis formationis fœtûs*, Konigsberg, 1814.

1st. The nervous system, which forms before all the other parts, is never united with the ovum.

2d. A film is gradually developed in the midst of the fluid of the amnios, which is the fetus.

3d. The fetus is straight originally, although it is the general opinion that it curves from the moment of its origin.

All these arguments are easily refuted.

In fact the part first formed has not been strictly determined. It seems probable to us that the rudiment first seen is the common base of several parts, and even in the inferior animals one organ, and in the most inferior the apparently homogeneous substance of their body represents several organs at the same time. Secondly, we can well conceive that the nervous system appearing first, it is primarily connected with the envelops of the ovum.

The second argument does not rest upon facts; and we do not see why the fetus could not be formed straight as well as curved from some portion of the ovum.

Finally, another circumstance also exists against this opinion, viz. the membrane of the amnios and the liquid it contains certainly appear after the fetus in birds, and the fetus of these animals is connected with the ovum at its first appearance.

The same is true doubtless of the human fetus. It is developed then on the ovum, and at the expense of one of its parts.

Another question now presents itself: At the expense of what part of the ovum is it developed, and how does this development occur?

Judging from analogy with the other vertebrated animals, the human fetus is very probably developed upon the umbilical vesicle, and at its expense. But analogy alone does not merely favor this hypothesis, in support of which we may also alledge the greater considerable size of the umbilical vesicle at first, and the position of the lower part of the fetus directly upon this pouch.

II. FORM.

§ 2598. After its origin the fetus presents an almost infinite number of degrees in its form and structure, the most general of which have already been mentioned in the introduction, while treating of the eight laws of the organic formation, or in descriptive anatomy, in stating in regard to each system and each organ the peculiarities which characterize it at different periods of its development.

The body of the fetus is longer at its first appearance than it is subsequently.

The portion of its body which appears first, corresponds almost exclusively to the trunk; we only remark at its upper part a small prominence separated from the rest by a fissure, which is by no means equal in thickness to the central part of the body. This prominence is the rudiment of the head.

As yet there is no trace of extremities, nor of the other prominences, particularly of the nose, the ears, and the genital parts.

The fetus has then the form of a worm.

It is entirely or almost entirely straight; we only remark that the dorsal face is slightly convex, and the abdominal slightly concave.

It is attached to the inner membrane of the ovum directly, or by a very short umbilical cord at its lower extremity, or by the part of its body directly above this extremity.

When the umbilical cord is inserted above the lower extremity of the body, this extremity slightly curves from behind forward, in the form of a tail.

All the openings which afterward exist are now completely closed.

The head gradually becomes proportionally large, so that towards the commencement of the second month it forms nearly half of the whole body. It is generally smaller before and after this period.

The body of the fetus curves much at its upper and lower extremities: the head is continuous with the trunk at a right angle, and its lower portion, which corresponds with the chin, is attached only to the top of the chest; the trunk is perfectly straight; there is no trace of the neck externally until the end of the second month.

Until the middle of the third month the lower extremity of the vertebral column is curved from behind forward and from below upward, projects below the anus, and represents the rudiment of a tail, which is at first very long; this gradually shortens and finally disappears entirely, but it is always attached by its inner face.

The limbs appear in the fifth week of pregnancy: the superior generally a little sooner than the inferior. They then have the form of small tubercles terminated by a blunt summit. The superior are situated directly below the head, and the inferior directly before the caudal extremity. Both proceed from behind forward, but a little also from within outward, on account of the greater development of the abdominal cavity. Sometimes also the superior go a little from above downward, and the inferior slightly from below upward, but this arrangement is by no means constant; they often also, particularly the inferior, assume an entirely opposite arrangement.

During the sixth week, and until the seventh, the stump which first appeared and which gradually lengthened, is divided into a peripherical and a central segment: these segments correspond to the hand and fore-arm, to the foot and leg.

One or two weeks afterward a third appears, which represents the arm and the thigh.

The segments formed last are much shorter than those which existed previously, although the contrary is true when the fetus is perfectly developed.

About the period when the stump of the limb begins to divide into an internal and an external part the latter becomes round, and enlarges at its loose extremity, and a single band-like eminence is frequently developed at its summit, from which it is separated by a depression.

This eminence soon gradually divides to form the fingers, which are at first proportionally short and thick, and which until the third month are still united by a thin substance similar to the membrane between the toes of web-footed animals, or the bones of the fins in fishes.

This uniting substance, this thin membrane, gradually disappears from the summit to the base of the fingers and toes.

The upper limbs appear before the lower; they also pass through all their successive degrees of formation more rapidly than the latter. They are for a long time absolutely larger, so that at five years of age the four limbs have nearly the same length.

When the limbs appear we begin to see also the external genital organs, the nose, the eyes, the ears, and the mouth, the successive development of which follows the course mentioned when treating of each of these organs.

The insertion of the umbilical cord gradually ascends. The umbilicus, however, is still proportionally much nearer the symphysis pubis in the full-grown fetus than in the adult, which difference is directly connected with the gradual diminution of the liver.

III. GROWTH.

§ 2599. The fetus, which is at first only some lines long, gradually becomes in ten lunar months about a foot and a half in length, and about six pounds in weight.

The increase is very rapid at first, and afterwards is gradually slower. It is asserted that it diminishes at the second month, that it becomes more active in the third month, but especially during the second half of the fourth, that it is evidently most rapid in the centre of pregnancy, and that it consequently becomes slower until the end of pregnancy.(1) This proposition is proved with difficulty, for individual differences may easily lead into error. We may however conceive it to a certain extent, by attributing this slowness to the disappearance of the umbilical vesicle about this period, and that it is not completely replaced by another mode of nutrition.

IV. VITAL PHENOMENA.

§ 2600. At the period of its appearance the fetus never makes part of the organism of the mother. Its relations with the mother are the same as those between the child and the external world. It lives a peculiar life, as is demonstrated by the mode of connection between the two organisms mentioned above.

(1) Autenrieth, *Suppl. ad. hist. embryon.*, p. 415.—Sœmmerring, *Icones embryonum*, p. 3.

Among the vital phenomena those connected with the formation are developed in the greatest degree, and at the expense of the rest. This is proved by the rapidity with which the fetus increases in weight and volume.

But the different functions of nutrition take place precisely in the same manner in all essential respects before and after birth. We have already mentioned the activity of the urinary secretion. The intestinal canal and the skin are also active.

§ 2601. We find very early in the intestinal canal of the fetus a fluid which has not the same qualities at all periods. Until about the centre of fetal existence this liquid is whitish and mucous: but it afterwards changes to a yellowish green, which is thicker and more viscid. It gradually becomes of a darker color in the large intestine, until finally in the latter periods of pregnancy it has the same qualities in the whole intestinal canal, so as to distend it. It is termed the *meconium*. It is formed of about two thirds of water, about one third of a peculiar substance, similar to vegetable matter, and of some hundredths of mucus.(1)

Opinions vary in regard to the origin of the meconium. Some consider it a residuum of the fluid of the amnios swallowed by the fetus; others think it formed from the secretion of the intestines.

Although the fetus very probably swallows and digests the fluid of the amnios, yet as meconium has been found also in the intestines of fetuses destitute of a head and mouth,(2) in a portion of the canal situated below a septum which interrupted the continuity of the tube,(3) in a separate end of the intestine which was closed in every part, in the rudiment of a fetus adhering to another regularly formed fetus,(4) and finally in the intestines of another perfect body,(5) it is clear that the deglutition of the waters of the amnios are not necessary to produce it. If consequently we sometimes find it only above the obstacle, when the intestinal canal is obliterated in any part,(6) we must not conclude from this that the fluid of the amnios has been swallowed, and that the meconium is formed from it,(7) but it follows at most that the secretion takes place principally at the upper part of the alimentary canal. We thus explain the peculiar color of the meconium, which might be attributed to the bile, since the tint of this fluid changes at the same time with it,(8) as we have ascertained, and

(1) Bouillon-Lagrange, in the *Annales de chimie*, vol. lxxxvi. and lxxxvii.
(2) R. de Graaf, *De mulier. org.*; in the *Opp. omn.*, p. 292.—Odhelius, in the *Schwed. Abhandlungen*, 1785, p. 176.—Gilibert, *Advers. med. pract.*, p. 132.
(3) Pied, in the *Journ. de med.*, an. x., frimaire.
(4) Simmons, *Medical facts*, vol. viii., London, 1800, p. 7.
(5) Brugmans, in Bernard, *Quæst. var. med. argum.*, Leyden, 1796. *De meconi. origine*, p. 31.
(6) Horch, *Eph. nat. cur.*, dec. iii. a iii. p. 188.—Desgranges, in the *Journ. de méd.*, an. x., thermidor.—Osiander, *Neue Denkwürdigkeiten*, vol. i. p. 179.
(7) Osiander, *Handbuch der Entbindungskunde*, vol. i. p. 237.
(8) Lobstein, p. 132.

as in an acephalous full-grown fetus the intestine contained a viscous, semitransparent mucus, not colored black.(1)

It, however, remains to be ascertained whether this hypothesis has any foundation, since the authors who describe the cases mentioned by us formally indicate the existence of a yellow matter having the qualities of meconium, and chemical analysis has not proved in it the existence of bile.(2)

However this may be, the bile seems to have some part in producing the meconium. In fact in some cases, particularly in that mentioned by Sims, and the subject of which was a child two years old, obliteration might be caused consecutively; in others, as in that described by Brugmans, some difference is stated between the meconium in that portion of the intestine which communicated with the biliary system and that inclosed in the lower intestine. Thus although the bile is not found in this fluid, it may perhaps contribute to produce it. Possibly also when the liver is deficient the intestinal canal supplies the action of this gland.

§ 2602. The surface of the body of the fetus is covered with a substance of a peculiar character, termed the *vernix caseosa*.(3)

This substance is yellowish white, viscous, and fatty.

From its chemical composition it is between the fibrin and the fat, and very much resembles adipocere.(4)

It does not exist during the whole of gestation, but begins to appear about the sixth month.

Opinions are divided in respect to its origin. Some consider it as a precipitate from the waters of the amnios deposited on the surface of the body of the fetus :(5) others think it is secreted by this latter.(6)

This last opinion is very probably more correct than the other. In fact :

1st. The glandular system, particularly that of the sebaceous glands of the skin, is much more developed in the fetus than subsequently.

2d. The vernix caseosa is very abundant in the parts where these glands are very numerous, in the head, the axillæ, and the inguinal regions.

(1) Monro, *Trans. of a soc. of Edinburgh*, vol. i. p. 216.
(2) Simmons, *loc. cit.*, p. 7.
(3) J. J. G. Schulz, *De ortu et usu caseosæ vernicis*, Helmstadt, 1788.
(4) Buniva and Vauquelin, *Annales de chimie*, vol. xxxiii.—Emmert and Reuss, *Chemischi Untersuchung des Fruchtwassers aus dem zeitigen Ei und der käsigen Materie auf der Haut des neugebornen Kindes ;* in Osiander, *Annalen*, vol. ii. p. 122.
(5) Boehmer, *De aquis ex utero gravid. et partur. profl.*, Halle, 1769, § ii.—Schulz, *loc. cit.*
(6) Levret, *Art des accouchemens*, 1766, p. 75.—Schulze, *Anweisung zur Hebammenkunt*, Hildburgshausen, 1770, p. 49.—Wrisberg, in Rœderer, *Elem. artis obstct.*, note 37.—Bmmert, *loc. cit.*, p. 134.—Lobstein, *loc. cit.*, p. 99.—Hunter, *Anat. des swang. Uterus*, p. 96.

3d. It is found only in the fetus: the membranes of the ovum and the umbilical cord present no trace of it.

4th. It is very similar to the substance furnished by the sebaceous glands of the glans penis, and its qualities do not allow it to be regarded as a precipitate from the waters of the amnios.

§ 2603. We shall demonstrate hereafter that the fetus respires by means of the placenta.

We shall also mention the differences presented in it by the fetal circulation.

§ 2604. The motions of the voluntary muscles are but slight. They generally begin to be felt about the middle of pregnancy, although we cannot conclude from this that they do not occur before, since they may be unperceived on account of the smallness of the fetus, and the abundance of the waters of the amnios.

§ 2605. The fetus necessarily derives in the body of the mother the materials for its growth, preservation, and its secretions. But here a question presents itself: Are there or not several modes of nutrition?

Different authors, particularly Hippocrates, Aristotle, Galen, Monro,(1) and Danz,(2) admit only one mode of nutrition, and consider the umbilical vein as the only channel through which nutrition comes to the fetus.

Others believe in the existence of several other channels, as the skin and the system of the mucous membranes, in a greater or less extent. According to this last hypothesis, the waters of the amnios are the source of nutrition for the fetus.

Several ancient writers, cited by Haller,(3) and among the moderns, Vas,(4) Brugmans,(5) Van der Bosch,(6) and Osiander,(7) admit that the skin absorbs.

Opinions vary much in regard to the extent of the portion of the system of the skin which contributes to nutrition.

According to Harvey,(8) Lacourvee,(9) Haller,(10) Treu,(11) and Darwin,(12) absorption takes place only by the intestinal canal.

Schcel(13) asserts that it occurs also by the lungs, into which the waters of the amnios come through the mouth and nose.

(1) Monro, *Essay on the nutrition of the fetus;* in the *Ed. med. essays*, vol. ii. p. 102.
(2) *Zergliederungskunde des neugebornen Kindes.*
(3) *El. phys.*, vol. viii. p. 205.
(4) C. J. Vos, *De nutritione imprimis nervosa*, Utrecht, 1789.
(5) In Van den Bosch, *De naturâ et utilitate liquoris amnii*, Utrecht, 1792.
(6) *Ibid.*
(7) *Handbuch der Entbindungskunde*, vol. i. p. 237.
(8) *De generatione*, Amsterdam, 1662, p. 253, 368.
(9) *De nutritione fœtus in utero paradoxa*, Dantzic, 1655.
(10) *El. phys.*, vol. viii. pt. i. p. 201.
(11) *De chylosi fœtus*, Altdorf, 1715.
(12) *Zoonomie*, vol. i.
(13) *De liquoris amnii utilitate*, Copenhagen, 1795.

To these parts Lobstein(1) adds the genital organs also.

Finally, Oken(2) thinks that the mammæ also absorb; but instead of admitting, as had already been done,(3) that the fetus absorbs the milk secreted by its proper mammæ, he asserts that these latter organs absorb only the waters of the amnios, and that the fluid introduced by them is carried by their lymphatic glands into the thymus gland, whence it enters the thoracic canal.

The following have been considered also as sources of the nutrition of the fetus:

1st. The fluid of the umbilical vesicle.(4)

2d. That of the allantoid membrane.(5)

3d. The gelatine of Wharton.(6)

Those who maintain several modes of nutrition think that they are brought into use simultaneously or successively. The first opinion has more supporters than the second.

We can hardly arrive at positive results until we have mentioned and discussed the arguments of each party.

§ 2606. Those physiologists who think that the materials of nutrition are brought to the fetus through the umbilical vein, rest their opinion upon the following facts:

1st. The constant and general existence of the umbilical cord, the chorion, and the placenta.

2d. The peculiar structure of these organs, and their connections with the fetus.

3d. Their early appearance.

4th. The villosities of the chorion are at first only venous, so that they have no function but that of absorption.(7)

5th. The fatal consequences which the interuption in the circulation of the blood causes in the nutrition and vitality of the fetus.

The arguments cited by the partisans of nutrition by the waters of the amnios generally, are:

1st. The existence of nutritious materials in this fluid.

2d. The gradual disappearance of these materials, and the diminution of the liquid near the end of pregnancy.

3d. The fetus continues to live and be nourished, although the cord is altered in texture, obliterated, and even entirely separated from the body, the umbilicus being perfectly closed at birth.

(1) *Essai sur la nutrition du fœtus*, p. 102.
(2) *Zeugung*, Hamburg, 1805, p. 162.
(3) Danz, *loc. cit.*, vol. ii. p. 71.
(4) Needham, *De formato fœtu*, London, 1667, p. 79.—Blumenbach, *Specim. physiolog. comp. inter animalia cal. sang. ovip. et vivip.*, Gottingen, 1786.—Id., *Instit. physiol.*, p. 449.—Sœmmerring, in Haller, *Grundriss der Physiologie*, 1796, vol. ii. p. 800.—Lobstein, *loc. cit.*—Emmert, *Ueber das Nabelblaschen;* in Riel, *Archiv. für die Physiologie*, vol. x. p. 77.—Joerg, *Zeugung*, p. 286.
(5) Harvey, Lobstein, Oken.
(6) Lobstein.
(7) Lobstein, *loc. cit.*, p. 117.

4th. It is a fact that no substance can be placed next to the body, but a mutual action and reaction is established.

5th. The parts with which the fluid of the amnios is in relation possess the power of absorption.

We consider the following as facts which demonstrate absorption particularly by the skin:

1st. The experiments where the lymphatics of the skin are filled with the fluid of the amnios.

2d. The known instances of fetuses without a mouth and an umbilical cord.

Those who think that the mucous surfaces absorb, rest their opinion on the following arguments:

1st. The necessity that the waters of the amnios should penetrate internally in cases of fissure of the mouth and palate, although the fetus does not become thinner.

2d. The existence of this liquid in the upper part of the intestinal canal, the lungs, and even the vagina.

3d. The products of digestion found in the intestinal canal.

4th. The downy hairs of the fetus found in the meconium.

5th. The motions of deglutition observed in fetuses immersed in the fluid of the amnios. Their attempts at biting and sucking before and after birth.

6th. The existence of the meconium at the upper part of the intestine, when the canal is interrupted in any portion of its extent.

Those physiologists who think that the liquid in the umbilical vesicle contributes to nutrition, cite:

1st. The analogy of this organ with the vitelline sac of the other vertebrated animals, and the evident passage of the liquid into the intestinal canal.

2d. The great size of the umbilical vesicle, then its wasting, attended with a change in the nature of the fluid within it.

We have already mentioned the arguments for thinking that the liquid of the allantoid membrane contributes to nutrition.

Those who think that the gelatine of Wharton also assists in this function, adduce:

1st. Its nutritious properties.

2d. Its abundance in the early periods of fetal existence, which is connected with the shortness and size of the umbilical cord, since the size of this cord does not depend solely on the presence of a greater number of parts within it.

3d. The observations of Noortwyk, Rœderer, and Uttini, which have shown that fluids can be made to pass into the gelatine of Wharton.

4th. The greater proportional development of the vessels and glands of the lymphatic system in the upper half of the anterior face of the

body on leaving the umbilicus, but principally in the anterior mediastinum,(1) which fact we have always proved.

§ 2607. Those who admit but one mode of nutrition, particularly that by the umbilical vein, adduce, first the fact that other channels, particularly the absorption of the waters of the amnios by the skin and the mucous membranes, are insufficient; and secondly that it is indispensably necessary to the life of the fetus for this passage should be open.

1st. The following reasons are alledged as leading one to think that nutrition by the waters of the amnios is not probable.(2)

a. The liquid is formed from the blood of the fetus.

b. It contains but little nutritious substance.(3)

c. A very marked alteration in its composition has no effect on the life or health of the fetus.

d. The fetus continues to live a greater or less length of time after the dribbling of the waters.(4)

e. The instances of the fetus having lived, although the umbilical cord was interrupted, obliterated, or separated from the body, are not authentic.

f. There is a considerable quantity of the amniotic fluid at the end of gestation.(5)

2d. Nutrition by the skin particularly has been opposed by the following arguments:(6).

a. The caseous envelop which covers it.

b. The necessary stagnation of the liquid in the cellular tissue after penetrating it.

c. The viscidity of the waters of the amnios, which render them unfit to enter through the skin.

3d. The arguments against the entrance of this liquid through the mouth are:

a. The want of similitude between the waters of the amnios and the fluid in the stomach.(7) The dissimilarity even between these waters and the meconium.(8)

b. The impossibility of swallowing unless respiration occurs.(9)

c. The frequent closing of the mouth.(10)

d. The fact that milk injected into the amnios does not enter the oral passages.(11)

(1) Lobstein, p. 139.—Monro, *loc. cit.*, p. 143.—Van den Bosch, *loc. cit.*
(2) Danz, p. 59.
(3) Van den Bosch, in Schlegel, p. 458.
(4) Van den Bosch, p. 458.
(5) Monro, p. 166.
(6) Haller, *El. phys.*, viii. p. 205.
(7) Monro, p. 163.—Van den Bosch, p. 460.
(8) Danz, p. 60.
(9) Danz, p. 59.
(10) Monro, p. 173.—Van den Bosch, p. 458 459.
(11) Monro, p. 175.

e. If the amniotic fluids penetrate into the oral cavity by any pressure, they would be introduced into the trachea as well as into the esophagus.(1)

f. Instances of acephalous and astomatous fetuses, which however were fleshy.(2)

g. The products of digestion found in the intestinal canal prove nothing, since they may arise solely from the action of this organ,(3) and the more as meconium also has been found above the point where obliteration had occurred.(4)

h. The existence of the meconium and the hairs in the stomach prove nothing, for hairs might be developed in the alimentary canal, and the meconium pass up through the intestines into the stomach.(5)

i. We may also consider deglutition and the sucking of the newly born child as valueless, since numerous other phenomena supervene at the period of birth, although the system has made no previous attempts, and the latter had already commenced before parturition by swallowing the waters of the amnios.

j. The existence of the amniotic fluid in the stomach is abnormal, and results from powerful compression.(6)

4th. We have already refuted previously the arguments which go to prove that the fluid of the allantoid membrane contributes to nutrition.

§ 2608. We have now to examine whether all the arguments alledged against the hypothesis that the fetus is nourished by the fluid of the amnios are sufficient to refute it.

Strict inquiry determines that they are not.

1st. It is not proved, and it is not even probable, that the waters of the amnios are formed from the blood of the fetus, since the vessels of the chorion may not necessarily be other than the organs of nutrition, and the fluid of the amnios may be secreted by the uterus.

2d. The slight proportion of nutritious materials proves nothing, because nutrition may be well performed with substances which contain less of it, and also because the fluid of the amnios at first contains more of it; finally because the greater energy of the formative power in the fetus is a sufficient compensation.

3d. The third and fourth arguments prove at most only that the liquid of the amnios is not the only source of nutrition in the fetus, or that the fetus might exist for some time without it: even this latter circumstance does not follow, for it is not probable that the fluid of the amnios is ever reproduced after it has escaped.

(1) Danz, p. 59.—G. J. C. Themelius, *Comment. qui nutritionem fœtus in utero per vasa umbilicalia solum fieri, occasione monstri ovilli sine ore et faucibus nati ostenditur*, Leipsic, 1751.—Van den Bosch, p. 459.
(2) Danz, p. 60.
(3) Van den Bosch, p. 461.
(4) Brugmans, in Van den Bosch, p. 461.
(5) Monro, p. 177, 178.
(6) Danz, p. 59, 60.

4th. We cannot apply to several well attested cases of infants being born with the umbilical cord really obliterated, the too general objection that all those of this kind are not authentic; the only conclusion however to be drawn from this is, that the fetus can support for some time the interruption of its communications with the uterus through the medium of the cord.

5th. The existence of a great quantity of the liquid of the amnios at the end of pregnancy, is without value, since the absolute quantity of the liquid is generally very much diminished at this period. If it is less in quantity in the latter periods of gestation, the only conclusion to be drawn from this is, that it is then less necessary, which coincides with the hypothesis that it serves for nutrition, as the formative acts have then more power, and also possibly another more efficacious mode of nutrition is then developed.

The arguments adduced against nutrition through the skin are easily refuted.

1st. The vernix caseosa does not exist in the early periods of gestation, that is, when the fluid of the amnios contains most nutrition, and when the formative acts are most rapid. Even when it is seen, it does not form on the skin a uniform layer which covers it so as to prevent absorption.

2d and 3d. There is no proof that the stagnation of the amniotic fluid under the skin is neeessary, and of the impossibility of its penetrating farther. This stagnation, on the contrary, is very improbable.

The arguments adduced against nutrition by the mouth are not conclusive: for,

1st. The dissimilarity between the fluid in the stomach and the fluid of the amnios is easily explained by a change in these latter; farther, we have often remarked a perfect identity between the two fluids.

2d. The impossibility of swallowing without breathing is not demonstrated, and certainly is not a fact. Farther, the fluid of the amnios might enter into all the cavities, without being swallowed.

3d. The closing of the mouth is a useless argument, since this does not always occur, and the mouth has been observed to be open in the fluid of the amnios.

4th. The same is true in regard to the non-entrance of the milk, for in these experiments the animal was dead.

5th. The penetration of the fluid of the amnios with the trachea is unattended with inconvenience; perhaps even it is useful. Farther observation seems to demonstrate that it really occurs.

6th. The acephalous fetuses only prove that this passage is not the only channel through which nutrition takes place.

7th. The development of the hairs is so rare a phenomenon that the constant existence of these hairs in the meconium should be considered as a very peremptory argument in favor of the introduction of the fluid of the amnios into the alimentary passages, although the presence of the meconium proves nothing. Besides these hairs resemble the silky down of the fetus.

8th. Although we reject, and with reason, the opinion that swallowing of the waters of the amnios would be a kind of prelude to sucking and deglutition, it does not follow that when this liquid is found in the stomach its presence should be regarded as unusual.

§ 2609. Thus the nutrition of the fetus by the fluid of the amnios still continues at least very probable.

It is no less difficult to doubt the nutrition by the fluid of the umbilical vesicle and the gelatine of Wharton. We have reason to think that the whitish fluid contained in the placenta constantly passes into the body of the fetus through the umbilical cord.

But it is very improbable that the fluid of the allantoid membrane contributes to its nutrition.(1)

§ 2610. We have now to examine if nutrition by the umbilical vein rests on as firm a base as those assert who think it the only source of nutrition.

We cannot at least deny that the contrary opinion can be maintained, since the facts alledged prove only the necessity of the circulation of the blood in the chorion and placenta, but establish nothing in regard to the function of these parts.

Farther, as the fetus is nourished in three other modes, and as it cannot be proved that these three modes are insufficient, we have a right to admit that the circulation of the blood in the placenta by the vessels of the fetus has not the uses commonly assigned to it, provided always that we mention others which are probable.

But this is possible. In fact this function corresponds to respiration; several physiologists, both ancient and modern, have compared the placenta to the lungs.(2)

The arguments in favor of this opinion are:

1st. The general necessity of respiration, which cannot be performed in any other manner.

2d. The analogy between the pulmonary and placental circulations, the placenta and lungs both receiving the blood, from which the se-

(1) G. F. St. Hilaire (*Monstruosités humaines*, p. 279) having found in the intestinal canal an anomocephalus of real fecal matters, moulded even into lumps in the post-cœcal intestine, was led by this phenomenon to examine the proper nutrition of the fetus. He thinks that the mucus secreted in the alimentary passages, and which is in too great a quantity to be used simply as a lubricating fluid, is the aliment first digested; that it is taken up at first by the digestive organs, then by the chyliferous passages, it is the source of the nutritious fluid, which thus flows constantly into the circulatory system, and which at each passage is gradually animalized. Considered in this manner, the nutrition of the fetus would resemble that of the adult. This hypothesis, in accordance with which the discharge of mucus would be caused by the irritation of the mucous membranes by the bile, is very ingenious, but is improbable. In fact we should be obliged to admit that the alimentary tube acts in two totally different ways in regard to the mucus, one action forming the mucus, the other converting it, changing it into chyle. F. T.

(2) Mayow, Duverney, Vallisneri, Cheselden, Hérissant, Bœrhaave, and Jampert, in Haller, *Elem. physiol.*, vol. viii. p. 254.—Eckardt, *Questio an duæ arteriæ umbilicales fœtui pulmonum loco inserviunt*, Jena, 1761.—E. Darwin, *Zoonomie*, vol. i.—B. N. G. Schreger, *De functione placentæ uterinæ*, Erlangen, 1795.—Lobstein, *loc. cit.*—Oken, *Der Atmungsprocess des Fötus;* in *Lucina*, vol. iii. p. 294.

cretion and nutrition of the body are derived, and which must consequently be renewed.

3d. The analogy between the animals which breathe by bronchiæ, and the fetus of the animals which have lungs.

4th. The rapidity with which death ensues, when the circulation through the placenta is interrupted.

5th. The analogy with birds and reptiles, in which the blood of the umbilical vessels really undergoes through the egg-shell the changes produced by respiration.

Very probably then the blood of the fetus is really changed in the placenta, similarly to what it is in the lungs, and the arterial blood of the mother replaces the circulating medium, which is acted upon by the oxygen.

We cannot adduce against this hypothesis that there is no difference in the color of the blood in the umbilical vein and arteries, as several observers worthy of confidence have proved, and as we have satisfied ourselves on several occasions; for possibly the fetus having but little need of oxygen its blood absorbs but a small quantity, and consequently its color is but slightly changed.

Schweighæuser has advanced an opinion directly the opposite of this.(1) He thinks that the function of the placenta is to change that which the umbilical veins bring to it into venous blood, and which does not suffer this change in the body of the fetus, in order to render it proper to secrete the bile and to form the solid parts, particularly the nervous system. But this hypothesis is supported by no fact, but it is opposed by several. Thus nutrition in general, and that of the nervous system particularly, is performed by the arterial blood; the bile *may* be formed from this blood. Besides the respiratory function of the placenta is imperfect, and consequently the difference between the blood in the umbilical vein and arteries is almost nothing. We cannot consider that of the vein as pure arterial blood, since it has already circulated very extensively in the upper half of the body. Finally, in the ovum of birds the blood of the umbilical artery is black, and that of the vein is red.

The placenta then is principally a respiratory organ, by means of the circulation in the umbilical vessels.(2)

(1) *Sur quelques points de physiologie relatifs à la conception et à l'économie organique du fœtus*, Strasburg, 1812, p. 19.

(2) G. F. St. Hilaire (*Philosophie anatomique*, p. 538) thinks that the fetus respires through all its pores like the aquatic insects, that it separates the air from the surrounding liquids, and that the uterus performs the part of the right ventricle by sending the amniotic fluid into all the integuments of the body. This opinion has been confirmed by Lassaigne's discovery of a gas very analogous to the atmospheric air in the amniotic fluid. Muller has enlarged upon this (*De respiratione fœtus commentatio physiologica*, Leipsic, 1823). This author thinks that the necessity of respiration of the fetus is to that of the child as 10 : 15, or as 2 : 3. But the placenta also concurs in it as well as the amniotic fluids. The fine experiments of Edwards on the asphyxia of the batracia are naturally connected with this great question, and may contribute to resolve it. F. T.

The liver probably assists in this function, since the umbilical vein ramifies very extensively before carrying the blood into the ascending vena-cava.

The more gross nutritious substance is introduced through the channels mentioned above.

But all these channels do not exist during the whole of fetal existence.

The umbilical vesicle first becomes inactive in the second month of pregnancy. After the first half of gestation, nutrition by the waters of the amnios diminishes much, because the fluid lessens in quantity and nutritious qualities, and the vernix caseosa diminishes absorption by the skin. It would seem then that latterly no other channel exists but the gelatine of Wharton.

V. DURATION OF THE FETAL STATE, AND BIRTH.

§ 2611. The fetal state usually continues ten lunar months. After this period the fetus is *born*, that is, it is detached from the body of the mother, and enters into a direct relation with the general organism, being now capable of an independent existence.

It however is frequently separated before the normal end of gestation; this is termed *abortion* (*abortus*). The union between the two organisms rarely continues too long; this is termed a *late birth* (*partus tardivus*, s. *serotinus*).(1)

The fetus cannot survive independent of the mother until the sixth month of gestation: even then it generally dies.(2) It has long been disputed to what extent beyond the common period the birth may be protracted; and the discussion is not terminated. The possibility of the fact cannot be doubted, and is attested by several authentic instances. We cannot, however, deny that a great many of them related depend on the necessity in order to render them legitimate, of a conception supervening in the mother, after the death of the husband.

§ 2612. Parturition is accomplished by the contraction of the uterus, aided by that of the abdominal muscles. These contractions commence at the base of the organ, while the slighter fibres of the neck gradually cease to act. Hence the cavity of the uterus shortens and contracts, and consequently all parts of the organ, except the lower, greatly compress the fetus, which escapes through the part which presents the least resistance, that is, through the dilated orifice of the uterus, whence it passes into the vagina, and then through the external orifice of the genital organs.

(1) *Ueber früh-und spätreife Geburten*, Mannheim, 1807.

(2) The case of a fetus, said to be only five months old, which lived nine months, has recently been reported. (V. Rodman, in the *Ed. med. and surg. Journal*, vol. xi. p. 455; vol. xii. p. 251.)

Usually, about as one thousand times to one, the membranes of the ovum, which enter the first, break before the fetus has left the cavity of the uterus, and most of the fluid of the amnios escapes. After the fetus is expelled the uterus is freed from the ovum, by the contraction of the organ following parturition, which very much diminishes the extent of the surface by which it adheres, and ruptures the vessels which unite the placenta. When the posterior fold is once detached the final contractions of the uterus cause its expulsion.

The connections between the ovum and the uterus are rarely destroyed by the first contractions of the latter, and the child is born enveloped in its membranes, like the young of the mammalia. This case probably happens only in continued pregnancies. It is normal, on the contrary, in abortion.

§ 2613. After parturition, lactation also establishes, for a greater or less length of time, a material connection between the mother and the child.

The mammæ during pregnancy are changed like the uterus. They enlarge, become more vascular, softer, and looser. Their granulations are more distinct. In a word, they resemble the other glands, the secretory activity of which continues uninterruptedly, while pregnancy assimilates the uterus to the muscles which are constantly in action.

The secretion of the milk begins in the last weeks of pregnancy, but it is very imperfect.

The human milk, like that of the other females of the mammalia, is decomposed by rest into two parts, one fat and yellowish, the other serous; the former, or the cream, divides into butter and buttermilk. The cream and the creamy milk both contain a substance analogous to albumen, the caseous substance, of which there is but little in the milk of the female, and it is there softer and less coagulable than in that of other animals. It is coagulated by heat and acids, and thus it may be obtained separately. The serous portion of the milk, when entirely freed from caseous substance, has a sweetish taste, which is owing to the sugar of milk, which abounds in the milk of the female. Many calcareous salts exist in the caseous matter. The slight quantity of this latter and its softness prevents the milk of the female from coagulating, or at least but slightly. It is asserted that its cream does not give butter, which is not true.

CHAPTER II.

OF CONCEPTION IN THE ABNORMAL STATE.(1)

§ 2614. The anomalies in the genital organs connected with coition, pregnancy, and parturition, are less numerous and less worthy of notice than those presented by the new organism.

I. GENITAL ORGANS.

§ 2615. An anomaly sometimes occurring in the organs of coition is the continuance of the hymen after copulation, and sometimes after parturition. It deserves attention, as it indicates that the presence of this fold is not a certain sign of virginity, and as it renders parturition difficult, particularly when the hymen is solid.

Among the anomalies of the genital organs of the female, of which we have already spoken above, the adhesion of the abdominal extremities of the Fallopian tubes with the adjacent organs, particularly with the anterior and posterior face of the broad ligaments, the uterus, the bladder, the rectum, and the ovaries, and the obliteration of their abdominal orifices, are principally results of coition. These two states are observed particularly in prostitutes,(2) where they are probably produced by the frequent and excessive stimulation of the genital parts. They are also common in sterile females, and should be regarded as the most usual cause of sterility, since they prevent the motion of the tubes, and the entrance of the fluid from the ovaries into the uterus.

II. NEW ORGANISM.

§ 2616. We shall examine here, among the anomalies which may supervene on conception and in the formation of a new organism, only those which affect the whole new being and the ovum particularly, since we have already mentioned the deviations in the formation of the fetus, either generally or particularly, in the several parts of this work.

1st. The first anomaly of the ovum is the place where it is formed. The anomaly is greatest in this case when the ovum is situated out of

(1) Wrisberg, *De secundinarum humanarum varietate*, Gottingen, 1773.—Schæfer, *De placentæ uterinæ morbis*, Leipsic, 1799.—Michaelis, *De placenta humana, anatomice, physiologice et pathologice considerata*, Erford, 1782.—Hebenstreit, *De funiculi umbilicalis pathologia*, Leipsic, 1747.

(2) Walter, *Ueber die Krankheiten des Bauchfelles*, p. 13.—Langstaff, in the *Med. chir. trans.*, vol. viii. p. 505.

the uterus. This is termed *extra-uterine conception* or *gestation* (*conceptio*, s. *graviditas extra-uterina*).(1) The ovum is then developed in the ovary, in the abdominal cavity, or in the Fallopian tube.(2) The uterus generally changes as it does in pregnancy; this organ is enlarged, softens, and a deciduous membrane forms in it. In the cases where it is asserted that the latter did not exist, it had probably already disappeared, or it was developed imperfectly.(3) The ovum is destitute of it.

As to the fetus:

a. It is regularly formed, a very rare phenomenon, observed principally in abdominal pregnancy.

b. It is dead; this is more frequent, and causes in the adjacent parts, principally the rectum, the integuments, or the vagina, rarely in the bladder, the formation of an abscess, and is usually discharged through the opening in pieces, more rarely entire.

c. Long before the first months of pregnancy have elapsed, and even during its first fifth, the too slightly extensible part in which the fetus is developed is ruptured, and the mother dies from an internal hemorrhage, which termination is observed particularly in pregnancy of the Fallopian tubes.

d. The fetus and its envelops less rarely adhere, and ossify more or less perfectly. The mass often continues so for years, and the female lives.

More commonly the situation of the placenta in the uterus varies, being developed, particularly in twin pregnancies, at the lower part of the ovum, on the edge of the orifice of the uterus (*placentæ prævia*, s. *oblata*).

Finally, a more common anomaly is the twisting of the umbilical cord.

2d. The simultaneous formation of several ova and fetuses. The following are the most general remarks on this subject:

a. There is generally a predisposition to this anomaly, since the same parents and the same mothers produce several twins.

b. The number of coexisting fetuses is never more than five. We may generally admit that twin pregnancies are to common pregnancies as 1 : 100, triplets as 1 : 1000, and quadruplets as 1 : 50,000–60,000.

(1) See our *Handbuch der pathologischen Anatomie*, vol ii. p. 160–180.—J. H. Giessmann, *Diss. de conceptione duplici uterina nimirum et ovaria uno eodemque temporis momento facta*, Marburg, 1820.—F. F. Susewind, *De graviditate ovaria*, Berlin, 1820.

(2) It may also be developed in the proper substance of the uterus, although not separated from the tissue of this viscus by a cyst. This has been observed by Schmitt, Hedrich, Carus, and Breschet. Carus (*Zur Lehre von Schwangerschaft und Gebert*, Leipsic, 1822) thinks, but wrongly, that in these cases the ovule glides and lodges between the peritoneum and the uterus. F. T.

(3) This occurred in a case reported by Langstaff. (*Med. chir. trans.*, vol. vii. p. 441.)

c. Generally in a case of twins or triplets the placentas are united in one, but there are two or three choria, two or three amnia, and two or three umbilical cords, so that the two or three fetuses are entirely separate. When two are situated in the same cavity the intermediate septum has evidently been destroyed.

The umbilical vessels usually communicate on the inner face of the placenta by a large transverse anastomosis, which arises at the root of the cord. This anastomosis is rarely deficient. This has been wrongly termed a third placenta.(1)

We do not as yet know how the umbilical vesicle is arranged where there are numerous fetuses.

d. In regard to the fetuses, even when there are but two, one and sometimes both are small and imperfect, often to a great degree, for most monsters which are very abnormal are generally twins.(2) This phenomenon is still more evident when there are more than two fetuses, for then all are generally smaller, and are not nourished as well as usual. Sometimes also the existence of two fetuses causes the death of one of them at a more or less advanced period.

e. In a twin pregnancy, and still more in triplets, parturition usually occurs before the regular period of gestation. Generally all the fetuses, and even those which are dead, leave the uterus at the same period. Sometimes, however, one of the two is expelled prematurely, while the second remains until the regular period, and is then born.(3) In some cases, but this is less remarkable, the dead infant is not born till some days after the other, which is perfectly full grown.(4)

The fetuses which coexist in the uterus have generally been produced by the same generative act. They are formed much less commonly by several successive actions; this constitutes *superfetation* (*superfetatio*).(5) The possibility of this fact is proved, first, by cases where the woman has borne two children of different color, and asserted that she had cohabited with men of different races; secondly, by those, although they are less authentic in fact, which mention full grown children born at an interval of several weeks, and even several months.

§ 2617. Superfetation is explained:

1st. By the existence of a more or less divided uterus.(6)

2d. By a productive coition, followed by another also productive, before the ovum produced by the first had arrived into the uterus.(7)

(1) Stalpart van der Wiel, cent. i. p. 75.—Otto, *Path. Anat.*, p. 38.

(2) Meckel, *Handbuch der pathologischen Anatomie*, vol. i. p. 55.

(3) J. Chapman, *Singular case of expulsion of a blighted fetus and placenta at seven months, a living child still remaining the full period of utero-gestation;* in the *Med. chir. trans.*, vol. ix. p. 194.

(4) Clarke, in the *Med. and phys. Journ.*, vol. xvi. p. 53.

(5) J. P. Gravel, *De superfetatione conjecturæ*, Strasburg, 1738.—M. Tydeman, *De superfetatione*, Utrecht, 1783.—T. Roose, *De superfetatione nonnulla*, Bremen, 1801.—J. C. Varrentrapp, *Comm. in T. Roose de superfetatione*, Frankfort, 1803.

(6) Gravel, Roose.

(7) Varrentrapp.

3d. By the laceration of a portion of the deciduous membrane, which forms a passage for the semen to the Fallopian tube.(1)

Thus all the theories given are purely mechanical. These explanations are by no means worthless; superfetation, however, more probably, depends principally on the fact that one coition calls into action several vesicles, which do not arrive at the same degree of vital activity simultaneously, even as in birds a single copulation is sufficient to impregnate a considerable number of yolks, which differ much in respect to their development.

Superfetation may also depend, in certain rare cases, on no mechanical cause, but on the fact that the capacity of the genital organs and the whole organism of the female is not unfitted by the first conception for a second during the course of the other; even as the disposition for contagious diseases, to which generation is so analogous, is commonly lost by the first infection, although a second supervenes in rare cases; or as one exanthematous affection is generally, but not always, arrested by another.

§ 2618. The new organism is sometimes destitute of certain parts. The most common anomaly in this case is the absence of the fetus, which undoubtedly depends generally on the fact that this latter has perished sooner or later, since the ovum is commonly formed of all the parts which normally compose it, and we there perceive even more or less evident proofs of the previous existence of a fetus.

The placenta is deficient more rarely. In one case of the kind recently described(2) it was asserted that the umbilical cord was attached to the inner face of the ovum in the form of a button.

The defect of an umbilical vessel, particularly of an artery, is more common.

We more rarely find the umbilical vein double, which establishes an analogy with most mammalia.

§ 2619. The deviations in the formation of the ovum relate principally to the placenta and the umbilical cord.

The placenta is sometimes but proportionally very rarely divided into several lobes (*placenta succenturiata*), only two of which generally appear, although there are sometimes seven. One of these lobes is generally larger than the others. This anomaly consists in a suspension of development. We have observed it principally in pregnancy with twins, and we have always been satisfied that authors were mistaken in saying that the umbilical vessels then divided unusually soon.

This premature division of the umbilical vessels, even within the membranes of the ovum, is rare: but it is still more so for the vessels to separate on the outside of the body of the child.

(1) Tydeman.
(2) Conby, in the *Salz. med. chir. Zeitung*, 1819, no. 43.

We must arrange here the knots of the umbilical cords termed *true*, when they are real,(1) and *false*, when they consist only in more or less compact circumvolutions of the umbilical vessels.

§ 2620. The umbilical cord presents anomalies in its extent. Sometimes it is too short, being only four inches in length. Less frequently it is unusually long, being fifty inches in length. Sometimes also it is very thin or *lean*, which depends on the small quantity of the gelatine of Wharton. In other cases it is unusually *fat*.

The placenta is commonly much larger and much thinner than usual in abdominal pregnancy.

Here are referred the change of the vessels of the placenta into larger and smaller vesicles, entirely closed and united by contracted portions, which seem to depend on the permanence and the ultimate development of a state primitively normal.

§ 2621. Anomalies in the connections relate to those of the ovum with the uterus or fetus. Sometimes, but rarely, the first are firm.

Sometimes the fetus is not connected with the ovum. This phenomenon is not rare in the early periods of gestation, and we may also consider it as the result as well as the cause of the death of the fetus. But authors relate also cases in which this insulation was observed at an advanced age of pregnancy. Here we refer to the observations of Chatton,(3) Stalpart van der Wiel,(4) Rommel,(5) Mason Good,(6) and Osiander.(7)

All these facts are not equally authentic. Thus Stalpart van der Wiel did not observe the case mentioned by him until several months after birth; there was at the time an inversion of the bladder; the umbilicus was situated too low, and blended with the upper part of the bladder, and seemed to be deficient.

On the other hand the fetus is sometimes connected with the membranes of the ovum too intimately.

Here are referred the cases where the umbilical cord is inserted in an unusual part of the body, and is there attached in a greater or less extent before arriving at the abdominal cavity.(8)

Such are also those(9) in which, besides the umbilical cord, a ligament arose from the membranes of the ovum, and was attached to the body of the fetus.(10)

(1) Delius, *De nodis veris in funiculo umbilicali*, Gottingen, 1805.
(2) Gregorini, *De hydrope uteri*, Halle, 1795.
(3) *Ephem. Gallic. ann.*, 673, fol. 69, cited by Stalpart van der Wiel, *Obs. rar.* cent. ii. pt. ii. p. 329.
(4) *Observat. rar. med. chir.*, cent. ii. pt. i. obs. 32.
(5) *Eph. nat. cur.*, dec. ii. ann. vii. obs. 209.
(6) Stark, *Neues Archiv.*, vol. i. p. 357.
(7) *Annalen*, vol. i. pt. i. p. 199.
(8) Meckel, *Handbuch der pathologischen Anatomie*, vol. ii. pt. i. p. 56.
(9) *Ibid.*
(10) G. F. St. Hilaire attributes the frequent monstrosities of the fetus which so frequently deform it, to these folds. F. T.

§ 2622. The principal alterations of texture are, the too great hardness of the membranes of the ovum, generally attended with their thickening: the development of the new formations in the placenta,(1) or of serous cysts in the cord; finally, the changes of the whole ovum, termed *moles*, and which are divided into several classes, according to the different substances which form them.

§ 2623. Parturition presents numerous anomalies, the causes of which exist in the body of the mother, or in that of the child, or in both. These anomalies become also the source of several of those mentioned when speaking of the genital organs, particularly of different deviations of formations, as lacerations of the uterus, the vagina, adhesion and obliteration of the orifice of the uterus, the vagina, and the vulva, after an injury.

(1) Clarke, in the *Phil. trans.*, 1798, p. 11.

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